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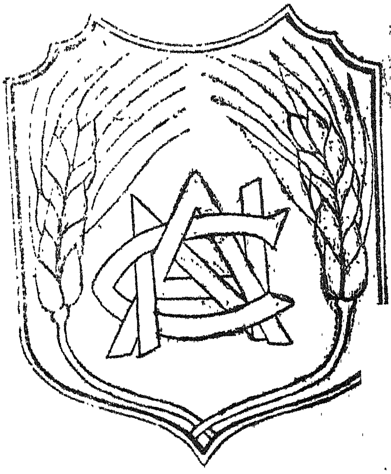

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Editorial

CONTROL OF LIVE-STOCK DISEASES IN INDIA

The control of animal diseases is a matter of serious concern to every country. Where agriculture and dairying form the chief occupation of many, the problem is all important. In India, cattle is the traditional form of wealth of agriculturists. To the dairy owner it is the principal asset. India is a major cattle owning country, her cattle wealth being one third of the world's cattle population. Apart from famine and drought which resulted in heavy cattle mortality from time to time, the toll of some cattle disease used to be very alarming. As an insurance against this danger, the keeping of larger number of cattle than the ordinary requirements of the cultivators became a common practice. The loss of cattle due to epidemics presented two very formidable problems viz. rendering veterinary aid to the affected cases, and securing immunity to others against the imminent contagion.

The urgency of initiating scientific effort in order to devise methods of treatment and to produce immunizing agents was rightly appreciated by the Government of India as early as half a century ago, when Dr. Lingard was appointed as Imperial Bacteriologist at Poona. He was entrusted with the following duties:—" To investigate diseases of domesticated animals in all provinces in India and to ascertain, as far as possible, by biological research both in the laboratory and when necessary, at the place of the outbreak, the means of preventing, and curing such diseases." To facilitate this work the laboratory was shifted to Mukteswar where it is now developed into the Imperial Veterinary Institute. The progress of Veterinary Science and practice in India is closely associated with the history of this institution.

The early attention of this institute was largely directed towards the major diseases viz. Rinder-pest, Anthrax, Hæmorrhagic Septicæmia and Black quarter for which immunizing agents were manufactured and issued on a large scale. With the gradual success in counteracting major ailments it was found necessary to expand its activities by organizing highly specialized research. Accordingly, investigation has now been divided into the following sections:—Pathology and Bacteriology, General Disease Investigation, Veterinary Zoology, Animal Breeding, Animal Nutrition, and Poultry diseases. Some prominent achievements in these different aspects of work are worthy of note. Rinder-pest which is the major bovine scourage in India can now be fairly controlled at a nominal cost by administering the Goat-blood virus. Similar success has been attained with regard to Hæmorrhagic Septicæmia, Anthrax and Black quarter. Foot and Mouth disease which is a highly contagious disease is of frequent occurrence. Though not deadly, yet, it results in considerable dislocation or break-down of the farmer's work, and is responsible for a serious economic loss to dairy industry. Ranikhet, Fowlcholera, and Fowlpox, the dreadful enemies of the birds are a nightmare of the poultry industry as they are known to lay bare a highly populous poultry farm in a very short time. Effective immunity against these diseases is now a possibility. Some diseases like osteomalacia, pica, goitre, and blindness in young calves are known to be due to mal-nutrition. Efforts are being directed towards finding the real needs of the livestock in this respect. A "balanced diet" with a sufficient supply of proteins, carbohydrates, fats, minerals and vitamins is being evolved. It is expected to stem the tide of deficiency diseases and to make the cattle strong and sturdy.

The measure of success attained with the years of labour and practice of the Veterinary Research Workers, in helping the stock owner, depends largely on the latter's co-operation, and the willingness of the provincial Governments to maintain the necessary staff and to provide vaccines and other biological preparations. The importance of immunizing the cattle before the outbreak of the disease is hardly realized by them. The fact that many of the cattle diseases are due to the infection of those "million murdering" microscopic organisms like bacteria, viruses and protozoa is something beyond their ken. The popular opinion that diseases are the result of Divine Wrath, still holds good in the interior tracts. The great need of education and intensive propaganda leading to a greater application of the scientific knowledge to the benefit of the stock owners is quite obvious.

The Imperial Veterinary Institute has done signal service to the advancement of Veterinary Science and practice in India for which it deserves to be congratulated on the occasion of its Silver Jubilee. A recent pamplet entitled " Research and Indian Agriculturist " which recounts its useful activities makes an interesting reading. Translations of the same in vernacular, profuse with illustrations, will serve as a good medium for propaganda.

Original Articles

ESTIMATION OF YIELD OF COTTON BY SAMPLING

By Mr. Dhannalal, L. Ag.

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Introduction.—Cotton is one of the most important crops in the Central Provinces and Berar, which forms the second largest cotton producing province in India. Berar in particular and some of the districts of the Central Provinces are specially favoured with climatic conditions and soil, admirably suited to the production of this crop. The total area under cotton during 1939—40 in these provinces was 3,511,929 acres which is about 17.36 per cent of the total acreage under cotton in the whole of India. Bulk of the cotton produced in these tracts is of short staple, although the area under long staple cottons evolved by the Department is rapidly increasing.

Locally, the cotton crop is generally sown 18″ apart by means of seed drill called Argada, the distance between plant to plant being 6″ to 9″. Exotic cottons like Combodia, and Buri on the other hand are sown wider apart, the distance between line to line being about 21″ and between plant to plant 10″. The usual practice is to give a higher seed rate and subsequently thin out the plants in the lines to the desired spacing. The seed rate varies from 16 to 20 lbs. per acre.

Cotton sowing is usually done about the third week of June depending upon the starting of the monsoon. The period of quickest growth of the plants is during August and September. The bolls burst somewhere about the third week of October when picking of kapas is started. Buri, Bani and such other cottons generally take a fortnight longer to mature; the fields are picked once every three weeks. Experience has shown that 2nd and 3rd pickings give the best lint and seed. As a rule four or five pickings are obtained, the last one coming off in January.

Object.—The estimation of the yield of cotton crop before harvest with a fair degree of accuracy is of considerable importance to overcome the elements of speculation. Importance of this subject has long been recognised. The Indian Central Cotton Committee has under its consideration the revision of standard yield figures for cotton and is contemplating to start a co-ordinated scheme for crop cutting experiments on cotton.

Recording of developmental data for estimating the yield of the crop has been practised by various research workers for some time past.

Balls (1) was the first to formulate the conception of plant scaffolding upon which the cotton is borne. He collected detailed data on growth, height, flowers and bolls etc. per plant per day and made use of these in his classical papers on the Analysis of Agricultural yield (2,3). Balls observed that a knowledge of developmental record leads to remarkable possibilities of forecasting flowering from growth and consequently of forecasting the crop. Balls and Holten (2) found that the yield of cotton plant was primarily dependant on the number of flowers which it formed. Flowering and bolling records have also been used by Trought (4) in estimating the variations in yield from year to year in the Punjab American 4 F.

Subsequent research by plant breeders and agronomists has however indicated that the final judgement on the yielding capacity of a new strain could not be passed, whatever the number of flowering and bolling records taken may show, unless it has been tested for yield in properly laid out trials for a number of years. Mohammad Afzal (5) has shown that ordinary flower and boll formation records alone cannot be used in the forecasting of yields. The possibility of forecasting yield of cotton under field conditions by sampling has been investigated by Kalamkar and Dhannalal (6) and Kalamkar (7) recommends for forecasting the yield the three factors viz. (1) the number of plants per unit area (2) the number of bolls per plant likely to contribute to the yield and (3) the weight of kapas from each boll by adopting a suitable sampling technique.

The object of this paper is to investigate the relation between stand, bearing and the yield of cotton by devising a suitable sampling technique.

Material and Method.—The material for the investigation was obtained from the varietal trial conducted at the Government Experimental Farm, Nagpur. The soil of this place is a stiff loam, known as black cotton soil, containing high percentage of clay. The average rainfall for the past 65 years is 50.39 inches, the rainfall during the year being 68.83 inches.

The sampling technique adopted was as under:—Each varietal plot under each replication was divided into two equal parts at right angles to the rows and in each half of the plots two sampling units were taken at random. The sampling unit was a five feet length of two adjacent parallel rows. The number of plants in each of the five feet length of the two adjacent parallel rows as well as the number of bolls likely to yield cotton were recorded at the time when the crop was ready for first picking. Weight of kapas per hundred bolls selected at random was also noted, five such samples being taken at each picking.

The layout of experiment is a randomised block consisting of eight varieties replicated six times. The plot size is 1/40th of an acre (33ft. x 33ft.) containing 23 lines of 33 feet length in each plot. The plan of the experiment together with the number of plants and number of bolls per sampling unit is as shown in appendix 'A.'

The sowing of the first three replications was commenced and completed on 8th and of the remaining three on 12th July 1940. The seed rate adopted was 16 lbs. per acre for all the varieties. The flowering of the varieties commenced from the 13th of September. The thinning was done on 27th July. The counts of the number of plants and bolls per unit length were taken on 17th November and the picking done on 27-11-40. 12-12-40, 29-12-40 and 22-1-41.

Plant number per sampling unit.—The mean number of plants per unit length of five feet together with the number of bolls for the eight varieties is given in table I.

TABLE I

Mean number of plants and bolls

Variety	No. of plants	No. of bolls	Adjusted bolls
1. H. 413	8.47	37.66	38.84
2. H. 414	9.60	42.70	41.59
3. H. 415	10.25	48.66	46.22
4. H. 420	9.31	41.06	40.54
5. H. 407	8.68	47.20	47.95
6. V. 434	9.52	46.00	45.05
7. Jarrilla	8.91	43.25	43.54
8. Local Jari	7.70	45.95	48.70
Mean	9.05	44.06	44.06
Standard Error (Mean of 48)	0.65	2.19	...

It will be observed that the mean number of plants per five feet length is 9.05. The highest number of plants per five feet length is 10.25 for H.415 and the lowest is 7.70 for Local jari. The analysis of variance given in Table II, however, indicates that the number of plants per five feet length for the different varieties does not differ significantly from the general mean. The value of 'F' is 1.4 while that required for 5 per cent point for $n_1=7$ and $n_2=35$ is about 2.29.

TABLE II

Analysis of Variance for plant number and number of bolls

Variation due to	Degrees of freedom	Variance for plant number	Value of 'F'	Variance for number of bolls	Value of 'F'
Blocks	5	22.508		56.810	
Varieties	7	29.567	1.44	622.925	2.69
Error (a)	35	20.463		231.292	
Between sub-plots	48	10.252		159.924	
Between samples	96	10.481		180.455	
Within samples	192	7.976		222.934	

The co-efficient of variability for the number of plants per five feet length works out to 49.97 and the Sampling Error to 35.76 per cent.

The comparison of the variance with 96 degrees of freedom for "Between Samples" and 192 degrees of freedom for "Within Samples" indicates that there is no significant difference between the two, showing that the structure of the sampling unit is satisfactory. Similar result is indicated in the case of analysis of variance for number of bolls.

Number of bolls per Sampling Unit.—The mean number of bolls per five feet length for the different varieties under observation is given in Table I. The mean number of bolls per five feet length is 44.06. The highest number of bolls per five feet length is 48.66 for H.415 variety and the lowest recorded is 37.66 for H.413. The analysis as per table II indicates that there is a significant difference between the number of bolls for the different varieties. The co-efficient of variability per five feet length is 34.68 and the Sampling Error is 30.48.

There is no significant difference between the variance due to "Between Samples" and that due to "Within Samples" as already observed. On the contrary the variance due to "Within Samples" is slightly higher than that due to "Between Samples" showing that there is a slight negative correlation between the two five feet lengths in the Sampling Unit.

Analysis of variance and covariance between the number of plants and bolls. The data on the number of plants per five feet length and the number of bolls is given in Appendix 'A.' The study of correlation between number of bolls and plants would prove interesting. The analysis of variance and covariance is given in Table III. 'x' stands for the number of plants and 'y' for the number of bolls.

TABLE III

Analysis of Variance and Covariance

Variation due to	D.F.	$S(x^2)$	$S(xy)$	$S(y^2)$	b	bS (xy)
Blocks	5	112.54	− 66.24	284.05	...	...
Varieties	7	206.97	+ 238.78	4360.48	1.15369	275.47809
Error (a)	35	716.23	+1056.09	8095.22	1.47451	1557.21526
Between sub-plots	48	492.13	+ 202.88	7676.38	0.41224	83.63525
Between Samples	96	1006.25	+2154.00	17323.75	2.14062	4610.89548
Within Samples	192	1531.50	+5644.00	42803.50	3.68527	20799.66388
Total...	383	4065.62	9229.51	80543.38		

The dependence of number of bolls on plant number can be judged by apportioning the sums of squares of deviation for the number of bolls into two parts viz. that due to regression and the remaining due to deviation from regression. It is desirable to use the regression co-efficient as determined from " Within Samples ".

TABLE IV

Test of Significance of Regression (Within Samples)

Variance due to	D. F.	Sum of Squares	Variance	Value of 'F'
Mean regression of bolls on plant number ...	1	20799.66	20799.56	180.54
Deviation from regression ...	191	22003.84	115.203	...
Total ...	192	42803.50	222.934	

The mean square due to regression of bolls on plant number is significantly higher than the mean square due to deviation from the regression line. It may however be observed that similar result is obtained by using the regression co-efficient as determined either from error (a) or from sampling error.

Regression Co-efficients for different varieties:—The analysis of variance and covariance with 192 Degrees of Freedom for " With Samples " is made up of 24 Degrees of Freedom for each of the eight varieties and is shown in Table V. The different values of regression co-efficients 'b' are also indicated.

TABLE V

Values of Regression of Co-efficients (Within Varieties)

Variety.	D. F.	S (x^2)	S (xy)	S (y^2)	b	bS (xy)	Mean Deviation from regression with 23 D. F.	Value of 'F'
H. 413	24	148.50	432.00	3349.00	2.90909	1256.7225	90.93	13.81
H. 414	24	260.50	899.50	5673.00	3.45297	3105.9465	111.61	27.82
H. 415	24	206.00	944.50	7506.00	4.58495	4330.4852	138.06	31.38
H. 420	24	135.50	399.00	2950.50	2.94464	1174.9113	77.20	15.21
H. 407	24	191.50	614.00	4970.00	3.20626	1968.6436	130.49	15.08
V. 434	24	217.50	704.50	4911.00	3.23908	2281.9318	114.31	19.96
Jarilla	24	283.00	1388.50	8055.00	4.90636	6812.4808	54.02	126.11
Local Jari	24	89.00	262.00	5389.00	2.94380	771.2756	200.77	3.84
Total ...	192	1531.50	5644.00	42803.50	3.68527	20799.6638		

5% 1%

$n_1=1$, $n_2=23$. F = 4.28 7.88

It will be observed that in all varieties excepting Local Jari, the contribution due to regression of bolls on plant numbers is significant compared to the deviation from the corresponding regression. The mean value of 'b' calculated from "Within Samples" is 3.68527.

The test of significance of differences of the regression co-efficient is indicated in Table VI.

TABLE VI

Test of Significance of Differences of the Regression Co-efficients

Variation due to	D.F	Sum of squres	Variance	'F'	5% 'F'
Average regression ...	1	20799.66	20799.66	181.37	3.98
Deviations of variety regressions from average regression ...	7	902.74	128.96	1.12	2.11
Eight variety regressions ...	8	21702.40	2712.80	23.66	1.97
Deviations from individual variety regression ...	184	21101.10	114.68		
Total ...	192	42803.50	222.93		

The contribution due to the average regression and also due to the eight varietal regressions is significant as compared with the mean squares due to deviations from varietal regression with 184 Degrees of Freedom. The variance due to deviation of varietal regression from average regression is not significant and hence the average regression can be taken as the best estimate of regression of number of bolls on plant number.

Varietal differences in number of bolls after allowing for possible effect of plant number: Analysis of residual variance.—The table of analysis of residual variance is prepared by using different estimates of error. It will be observed from Table VII that whichever estimate of error is used the varietal effects of bolls on plant number are significant.

TABLE VII

Analysis of Residual Variance for Varietal effect (Adjusted by using different estimates of regression)

Variation due to	D. F.	Sum of squares	Variance	'F'	5% 'F'
Varieties + Error (a)	41	10639.55			
Error (a)	34	6538.01	192.29		
Varieties	7	4101.54	585.93	3.04	2.30
Varieties + Between Samples	102	16176.17			
Sampling Error (Between Samples)	95	12712.86	133.819		
Varieties	7	3463.31	494.76	3.69	2.11
Varieties + Within Samples	198	27257.36			
Within Samples	191	22003.84	115.203		
Varieties	7	5253.52	750.50	6.51	26.0
Varieties + Sampling Error + Within Samples	294	40955.40			
Sampling Error + Within Samples	287	36165.56	126.01		
Varieties	7	4789.84	684 26	5.43	2.04
Varieties + Error (a) + Within Samples	233	35644.68			
Error (a) + Within Samples	226	30926.96	136.844		
Varieties	7	4717.72	673.96	4.92	2.14
Varieties + Error (a) + Sampling Error + Within Samples	329	48693.53			
Error (a) + Sampling Error + Within Samples	322	44130.50	137.051		
Varieties	7	4563.03	651.86	4.75	2.12

The number of bolls per five feet length adjusted for plant number using average regression based on "Within Samples" for the different varieties is shown in Table I. It will be observed that after correcting for plant number, Local Jari shows the highest number of bolls instead of H. 415 which showed the highest number of bolls when not corrected for plant number. H. 413 variety shows least as before.

Weight of Kapas from 100 bolls.—All the cotton from the experimental plots was removed in four pickings. It may be stated that in the final picking five samples of weight of kapas from 100 bolls were not available for all the varieties. Such a data is therefore analysed only for the first three pickings and is given in Appendix 'B' The statistical analysis of weight of kapas per 100 bolls is shown in Table VIII., for the three pickings combined.

TABLE VIII

Analysis of Variance: Weight of Kapas from 100 bolls.

Variation due to	D. F.	Sum of Squares	Variance	'F'	5% 'F'
Blocks	5	28.67	5.73		
Varieties	7	195.77	27.96	6.8	2.29
Pickings	2	226.08	113.04	27.5	3.27
Blocks x Varieties Error (a)	35	143.59	4.102		
Varieties x Pickings	14	23.31	1.16	0.55	1.82
Blocks x Pickings	10	166.49	2.081		
Blocks x Varieties x Pickings	70				
Sampling Error	576	130.84	0.227		
Total	719	914.75	...	...	

The analysis indicates that the weight of kapas from 100 bolls differs significantly for the different varieties as well as for the pickings. The interaction of varieties into pickings is not, however, significant. Analysis of data for individual pickings also confirms that there is significant difference between the weight of kapas from 100 bolls obtained for different varieties, as seen from table VIII (a).

TABLE VIII (a)

Analysis of Variance: Weight of Kapas from 100 bolls per picking.

Variation due to	D. F.	1st Picking		2nd Picking		3rd Picking		5% 'F'
		Mean Square	'F'	Men Square	'F'	Mean Square	'F'	
Blocks	5	1.62		6.35		2.09		
Varieties	7	9.80	5.4	9.97	3.9	11.51	2.9	2.29
Error	35	1.81		2.55		3.89		
Sampling Error	192	0.499		0.593		0.105		
Total	239							

The coefficient of variability of weight of kapas from 100 bolls per sample as determined from the data collected for three pickings works out to 11.36 per sample, and the coefficient of variability for sampling error is 2.68.

The mean weight of kapas per 100 bolls for the different varieties and pickings together with the respective standard error is shown in Table IX. It may be observed that the standard error for weight of kapas obtained from 100 bolls increases with subsequent pickings.

TABLE IX

Mean weight of kapas in tolas from 100 bolls

Pickings	Varieties								Mean	S. E.
	H. 413	H. 414	H. 415	H. 420	H. 407	V. 434	Jarilla	Local Jari		
1st.	18.65	18.22	18.59	18.30	19.05	17.38	17.48	18.37	18.25	0.245
2nd.	18.37	18.60	17.97	18.01	18.40	17.07	17.45	18.74	18.08	0.292
3rd.	17.12	16.97	17.08	16.93	17.69	16.05	16.22	17.83	16.99	0.360
	S. E. 0.380								S.E. 0.130	
Mean	18.04	17.93	17.88	17.74	18.38	16.83	17.05	18.31	17.77	0.213

H.407 variety closely followed by Local Jari gives the highest weight of 18.38 tolas of kapas per 100 bolls of cotton, while V.434 yields the lowest giving 16.83 tolas.

The order of merit is :—

H. 407	Local Jari	H. 413	H. 414	H. 415	H. 420	Jarilla	V. 434
18.38	18.31	18.04	17.93	17.88	17.74	17.05	16.83

The above data is put in a slightly different form to show the number of bolls to make 1 lb of kapas and is shown in Table IX (a).

TABLE IX (a)

Number of bolls to yield 1 lb of kapas

Pickings	Varieties								Mean
	H. 413	H. 414	H. 415	H. 420	H. 407	V. 434	Jarilla	Local Jari	
1st.	214	230	215	218	209	230	228	272	219
2nd.	218	215	223	222	217	234	229	213	221
3rd.	230	236	234	236	226	249	246	224	224
Mean	220	227	224	225	217	238	234	236	221

Percentage of kapas obtained in different pickings.—As already observed, about four pickings of cotton are generally obtained during the growth of the crop, 60 to 70% of the produce being obtained in the first two pickings. Second picking is generally heavier. Amongst the different varieties under trial, Jarilla is the earliest to mature and Local Jari stands last. Percentage of kapas obtained in the different pickings for the different varieties under trial is shown in Table X.

TABLE X

Percentage of kapas obtained in different pickings

Pickings	Varieties								Average
	H.413	H.414	H.415	H.420	H.407	V.434	Jarilla	Local Jari	
1st Picking	27.59%	31.15%	23.68%	32.18%	27.37%	32.35%	43.69%	22.09%	30.12%
2nd Picking	40.38%	39.73%	40.05%	40.57%	36.74%	35.35%	31.98%	35.93%	37.50%
3rd Picking	25.19%	22.45%	26.76%	21.36%	24.11%	22.97%	18.18%	28.70%	23.71%
4th Picking	6.93%	6.59%	9.50%	5.87%	11.75%	9.31%	6.27%	13.26%	8.69%

Estimation of yield by sampling.—The weight of kapas from 100 bolls has been found to vary significantly from picking to picking, there being a tendency for it to be less in the subsequent pickings. All the varieties excepting H.414 and Local Jari have given highest weight of kapas from 100 bolls in the first picking, while in H.414 and Local Jari the weight of kapas from 100 bolls obtained was highest in the second picking.

The picking of cotton depends upon the bursting of number of bolls, weather conditions, and availability of labour and as such there is no rigid interval in the different pickings of cotton, and therefore, the weight of kapas from 100 bolls as determind from second picking is utilised in the estimation of yields in the present case.

The yield of kapas as calculated from the estimate of number of bolls per plot and the weight of kapas from 100 bolls as per second picking is given in Appendix 'B'.

The analysis of the data is shown in Table XI.

TABLE XI

Analysis of Variance: Estimated yield

Variation due to	D. F.	Sum of squares	Variance	'F'	5% 'F'
Blocks ...	5	10.13	2.02		
Varieties ...	7	250.32	35.76	2.44	2.29
Error ...	35	513.13	14.66		
Total...	47	773.58			

The analysis indicates that the varietal effect is significant. The error per plot works out to 12.71%.

The analysis of actual yield is given in Table XII.

TABLE XII

Analysis of Variance: Actual yield

Variation due to	D. F.	Sum of squares	Variance	'F'	5% 'F'
Blocks ...	5	178.49	35.69		
Varieties ...	7	279.98	39.99	5.59	2.29
Error ...	35	251.06	7.17		
Total...	47	709.53			

It confirms the conclusion as obtained from estimated yield that the varietal effect is significant. The error per plot works to 8.67% as against 12,71 in the former case.

Comparison of estimated, actual and adjusted yield (allowing for plant number) in lbs. per plot.—The estimated, actual and adjusted yields allowing for plant number are given in table XIII.

TABLE XIII

Estimated, Actual and Adjusted yields in lbs. per plot

	Varieties								Mean	S. E.
	H. 413	H. 414	H. 415	H. 420	H. 407	V. 434	Jarilla	Local Jari		
Estimated	26.23	29.74	33.11	28.11	32.89	29.79	28.65	32.01	30.06	1.56
Actual	29.14	29.68	30.89	29.06	31.35	30.64	29.89	36.58	30.78	1.10
Adjusted (allowing for plant number)	27.07	29.35	31.52	27.70	33.48	29.18	28.83	34.63	30.22	

It will be observed that there is a very close agreement between the actual and the estimated mean yield. The difference between actual and estimated yields for the different varieties is also not significant except in the case of Local Jari, which is greatly underestimated. In this case it may be observed that the adjusted number of bolls per five feet length after allowing for plant number turned out to be the highest for Local Jari as seen from Table I. After allowing for plant number the agreement between the actual and the adjusted yield becomes much closer.

Possibility of forecasting of yield.—The analysis on the whole indicates that it is possible to forecast the yield of cotton by merely counting the plant population in unit area, the number of bolls per plant and the weight of kapas per boll. The number of bolls per plant which will ultimately contribute to the yield of kapas can conveniently be counted at a time when the crop is ready for first picking, although it is expected that no serious error will be involved even if the counting is done at the second or even third picking, as the septa of the bolls from which cotton is picked, generally remain on the plant. There is no formation of boll which will materially contribute to the increase in yield after the crop is ready for first picking. It is however likely that due to unfavourable weather there may be boll shedding subsequent to the observation taken, but it can be conveniently allowed for in estimating the yield.

The main advantage of the above method is that, it obviates the necessity of visiting the fields as many times as is necessary to pick cotton.

Summary and conclusions.—The possibility of estimating the yield of cotton by taking into account plant density in unit area, number of bolls and weight of kapas per boll is studied in the present investigation. The data refer to the experiment conducted at the Government Experimental Farm, Nagpur.

Sampling technique adopted for counting the number of plants and bolls consists in taking four sampling units, two from each half of the plot, the plot size being 1/40th of an acre. The sampling unit consists of two adjacent five feet parallel rows. The area thus sampled represents about 5.27% of the total area.

1. The mean number of plants per five feet length is observed to be 9.05 with a coefficient of variability of 49.97. The sampling error is 35.76% No significant difference in the number of plants per five feet length is observed for the different varieties.

2. There is a significant difference between the number of bolls per five feet length for different varieties. The mean number of bolls per five feet length is 14.06 with a coefficient of variability of 34.68 while a coefficient of variability of sampling error is 30.48.

3. There is significant correlation between the number of bolls and plants in five feet length.

4. Weight of kapas from 100 bolls is different for different varieties. H. 407 gives the mean highest weight of 18.38 tolas closely followed by Local Jari while V. 434 yields the lowest giving 16.83 tolas. Coefficient of variability of weight of kapas from 100 bolls per sample is 2.68. The standard error appears to increase with subsequent pickings.

5. The weight of kapas obtained per 100 bolls tends to decrease with subsequent pickings.

6. 60 to 70% of cotton crop is picked up in the first two pickings.

7. Very close agreement between the estimated and the actual yields is obtained; particularly after allowing for plant number.

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APPENDIX

Sampling data :

	H.413		H.420		Jarilla	
P	6—8	9—5	11—13	5—3	9—5	18—10
B	44—35	62—29	36—54	42—24	42—28	48—39
P	5—7	8—9	9—12	7—4	17—10	15—9
B	44—46	40—36	41—36	44—26	46—42	47—29
	H-414		H 407		Local Jari	
P	9—5	10—9	9-5	13—12	5—7	11—9
B	54—27	38—62	21—59	54—62	27—58	48—43
P	11—9	6—9	7—8	9—10	9—11	7—9
B	62—68	36—54	32—42	54—46	68—57	32—52
	H.415		V.434		H.413	
P	11—15	8—12	11—13	11—14	8—10	9—11
B	46—49	26—59	45—53	30—60	29—48	29—30
P	10—11	9—14	10—9	9—9	16—12	18—7
B	36—58	46—70	59—50	58—46	38—25	45—36
	H.420		Jarilla		H.414	
P	13—4	8—8	6—2	12—7	10—11	1—16
B	38—16	34—36	43—27	55—37	34—50	8—56
P	6—9	7—7	13—6	11—6	10—6	19—13
B	29—58	29—47	54—18	58—34	46—24	61—48
	H-407		Local jari		H.415	
P	9—12	4—8	10—11	8—10	13—14	3—13
B	44—53	51—62	58—66	27—65	51—68	12—86
P	8—10	17—11	11—9	16—14	17—18	12—13
B	28—54	82—52	53—36	57—63	51—57	62—52
	V.434		H.413		H.420	
P	12—12	6—8	9—9	9—8	5—10	8—8
B	38—54	30—55	37—30	28—27	28—51	38—35
P	12—9	5—8	7—6	7—9	8—11	8—8
B	41—42	36—50	28—23	35—41	44—45	28—32
	Jarilla		H.414		H.407	
P	7—10	5—9	10—8	14—9	9—17	12—7
B	23—32	29—95	53—36	54—28	29—57	47—29
P	8—11	5—10	6—6	7—8	4—10	9—10
B	35—46	36—85	31—60	28—48	27—47	52—53
	Local Jari		H.415		V.434	
P	6—10	8—6	8—9	12—13	7—7	11—9
B	42—56	32—62	54—58	48—54	36—52	69—65
P	7—10	9—10	8—3	9—11	6—7	10—9
B	39—40	23—78	41—20	42—64	24—55	35—63

P=Plants; B=Bolls.

A

Plant Numbers and Bolls

H.414		H.407		Local Jari	
9—10	8—5	2—8	5—6	4—5	5—8
42—49	33—35	20—46	37—48	28—44	15—46
13—20	8—13	6—6	10—11	7—11	5—6
35—34	28—38	46—34	46—60	56—54	31—31
H.415		**V.434**		**V.413**	
9—8	9—10	13—10	16—6	10—4	8—9
35—54	43—67	47—63	48—21	47—27	44—62
12—13	12—8	10—15	16—6	9—14	8—11
30—60	59—53	61—58	48—21	28—56	34—82
H.420		**Jarilla**		**H.414**	
9—13	12—8	10—9	18—10	5—13	8—13
65—57	49—45	76—43	66—46	27—70	50—72
10—14	10—12	7—10	18—10	8—10	11—11
37—35	35—32	35—53	60—22	34—30	44—46
H.407		**Local Jari**		**H.415**	
3—9	8—7	6—6	6—8	14—5	4—6
20—71	40—32	74—70	50—42	68—30	19—55
13—9	9—13	5—7	6—11	16—12	8—12
51—66	73—94	27—42	45—51	54—72	31—48
V.434		**H.413**		**H.420**	
7—5	10—10	6—11	9—9	14—12	9—12
46—36	60—46	30—40	39—41	56—36	43—70
7—7	10—7	7—5	6—9	9—13	6—9
45—44	56—50	33—21	36—34	36—64	34—59
Jarilla		**H.414**		**H.407**	
10—4	5—6	8—8	10—11	8—9	8—6
55—24	51—40	41—32	30—46	56—46	49—45
8—6	4—7	7—6	11—13	12—7	9—3
40—36	31—56	38—31	31—68	54—35	33—27
Local Jari		**H.415**		**V.434**	
7—4	3—6	7—6	17—8	6—12	6—12
67—35	40—23	39—34	54—32	15—57	19—36
5—1	5—10	8—7	8—7	9—16	11—6
32—11	55—55	44—40	60—45	35—65	54—31
H.413		**H.420**		**Jarilla**	
9—8	8—11	8—7	12—10	7—10	6—7
53—43	26—46	27—33	55—52	33—54	36—30
4—5	8—7	9—14	12—11	12—10	9—4
32—27	24—38	36—38	41—45	41—56	42—22

APPENDIX

Weight of Kapas per 100 bolls

	Picking			Picking			Picking		
Variety	1	2	3	1	2	3	1	2	3
H. 413	18.25	18.25	17.00	17.75	18.75	17.00	17.50	17.50	17.00
	17.75	17.00	16.75	18.75	18.25	17.00	18.00	18.50	16.50
	18.25	17.00	17.00	17.75	18.00	17.00	19.00	18.00	16.50
	18.50	16.75	17.00	17.25	17.75	17.00	17.75	18.25	17.00
	18.50	17.50	17.50	18.00	18.00	17.25	17.50	17.00	16.75
H. 414	18.75	18.25	17.00	18.25	19.75	18.50	17.75	18.00	17.25
	17.50	18.00	16 25	19.25	20.75	16.75	17.50	18.50	16.25
	17.75	18.00	15.75	18.50	19.00	18.75	17.75	17.50	17.00
	18.25	17.00	16.25	17.75	18.25	17.25	18.00	17.00	16.50
	17.25	18.00	16.00	17.75	18.50	18.50	17.50	16.75	16.75
H. 415	18.75	17.75	17.25	20.00	19.00	18.00	19.25	17.00	17.00
	18.75	18.25	17.25	19.00	18.25	17.25	19.00	17.00	17.25
	19.00	18.25	16.75	19.00	18.50	17.25	19.00	17.50	16.75
	17.75	17.00	16.75	17.75	17.75	17.75	19.25	17.75	16.25
	17.50	19.00	16.75	19.25	17.75	17.00	18.75	17.25	17.00
H. 420	16.75	17.50	18.25	18.50	17.25	16.75	18.00	17.50	17.75
	17.00	17.75	17.00	20.75	17.25	16.25	17.50	17.75	15.00
	17.25	17.25	17.25	18.50	17.75	16.50	17.50	18.00	17.00
	17.50	17.25	17.00	18.25	18.50	15.75	18.00	18.00	16.50
	17.50	17.00	17.00	17.75	17.25	16.00	20.50	18.00	16.75
H. 407	19.75	71.50	17.00	17.75	18.00	17.50	20.00	19.25	18.25
	21.00	17.75	18.25	17.50	17.75	17.25	20.00	19.75	17.50
	17.50	17.25	17.75	19.00	17.25	17.00	19.00	19.50	18.50
	18.75	17.50	15.50	18.25	17.75	17.00	20.25	21.25	18.25
	21.50	17.50	19 00	19.00	17.75	16.75	18.00	21.00	19.50
V. 434	18.00	16.75	17.00	18.50	16.75	14.50	17.50	18.25	17.25
	17.50	16.50	15.75	18.25	16.25	16.50	18.00	17.00	17.25
	16.75	16.75	17.25	16.75	16.00	15.25	17.75	17.25	16.75
	16.75	16.75	16.25	16.50	16.75	15.25	18.00	16.75	17.00
	17.00	16.25	15.75	17.25	17.00	15.75	18 00	18.50	17.00
Jarila	17.75	17.75	12.50	18.00	16.25	15.50	17.50	18.50	16.25
	18.00	18.25	16.00	17.00	17.00	16.50	16.75	16.50	16.25
	18.50	17.75	17.00	17.75	16.25	15.50	16.50	17.25	17.25
	17.50	18.00	16.50	17.00	16.75	17.00	16.75	17.25	16.75
	17.50	18.50	17.00	16 75	17.25	15.25	17.00	17.00	18.50
Local Jari	18.75	18.25	17.25	18.50	17.50	18.00	17.75	17.75	16.75
	17.75	18.50	17.25	17.75	18.50	16.75	17.50	17.25	17.00
	17.25	18.25	18.50	18.25	17.75	17.25	17.75	16.75	16.25
	16.75	17.25	18.25	18.25	18.00	17.50	17.50	17.25	17.25
	18.25	17.50	19.75	17.25	19.00	17.00	18.50	17.75	16.25

B

of three separate pickings per plot in tolas

Picking			Picking			Picking		
1	2	3	1	2	3	1	2	3
19.25	20.50	17.00	19.75	19.00	17.00	17.50	19.00	16.75
19.00	18.50	17.50	19.50	21.25	17.00	19.75	18.75	17.00
19.50	18.75	17.75	19.75	19.25	16.50	18.50	19.00	17.25
18.00	18.25	18.50	20.25	19.00	17.00	19.00	18.00	17.00
20.00	19.00	18.00	20.50	18.25	17.50	18.75	18.25	17.75
18.50	18.00	17.00	19.25	19.00	16.75	18.00	18.00	16.75
17.50	17.75	16.25	18.75	19.50	17.25	18.00	19.50	16.25
18.00	18.25	16.75	18.25	19.50	17.00	19.50	19.50	16.75
18.50	18.75	17.25	18.75	19.50	17.50	18.00	19.25	17.25
18.50	17.75	18.50	19.25	21.25	17.00	18.50	19.50	16.25
18.25	18.00	16.75	17.50	18.50	17.25	19.00	18.00	17.00
18.50	17.00	16.75	18.25	18.25	17.75	18.25	18.00	16.75
17.75	17.00	17.25	19.25	18.75	17.25	18.00	19.50	16.25
18.75	16.75	17.00	19.00	19.00	17.75	18.25	18.75	16.75
17.75	17.50	16.75	18.50	19.00	17.00	18.75	17.25	18.00
18.50	17.75	17.50	20.50	16.75	17.25	18.75	18.00	17.25
18.25	17.75	16.50	19.25	18.50	17.75	17.75	18.75	16.75
17.50	18.00	17.50	19.00	21.25	17.25	19.00	18.00	17.00
18.00	18.25	17.75	18.75	19.75	17.25	18.00	18.75	16.25
17.50	17.25	17.25	18.75	19.50	16.75	18.25	18.25	17.25
19.50	18.50	18.75	16.25	18.50	17.25	18.50	18.00	16.75
18.25	18.25	17.75	17.75	18.50	17.75	20.75	19.00	19.00
20.00	18.25	17.75	18.50	18.50	16.75	21.00	18.25	21.00
20.00	19.00	17.50	18.75	18.75	17.25	18.75	18.00	17.25
18.25	18.50	17.00	18.75	17.50	17.00	19.50	17.75	17.00
17.75	17.75	16.00	17.50	17.00	15.25	17.00	16.75	15.25
17.25	16.75	16.25	17.25	18.75	14.25	17.50	16.75	16.50
17.50	16.00	16.50	17.25	17.25	15.75	17.50	18.00	15.00
17.00	17.25	15.50	16.50	16.25	16.00	18.25	18.25	15.25
17.25	17.25	17.00	16.75	17.50	15.75	16.75	17.25	17.00
18.00	18.00	17.50	18.75	18.50	15.00	17.25	18.00	16.75
17.75	17.75	15.50	17.00	17.00	16.25	17.75	18.00	16.00
18.00	17.00	16.75	18.75	17.25	15.00	17.75	17.25	17.00
17.00	16.75	16.50	17.00	17.50	15.50	18.00	17.50	15.75
17.00	17.75	17.25	16.75	16.75	14.75	17.50	18.25	17.50
19.00	20.75	18.50	20.25	19.00	18.50	18.25	20.75	17.00
19.75	21.75	19.25	19.00	18.75	17.00	16.25	20.25	17.50
19.75	20.00	19.75	19.75	20.00	18.00	18.25	19.25	18.25
19.75	20.00	19.50	17.50	18.25	18.25	17.75	20.00	17.00
20.50	20.50	21.00	19.25	18.25	17.00	18.50	17.50	17.50

"GRAMA—VIDHAN" OR VILLAGE PLANNING

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Villages can be classified in three different ways viz:—(1) Use (2) Topography, (3) Population. The sub-classes of Use-classification may be enumerated as follows:—

(i) Agriculture, (ii) Pastoral, (iii) Forest, (iv) Vocational, (v) Manufacturing, (vi) Commercial or distributing, (vii) Religious, (viii) Educational, (ix) Strategic.

The sub-classes naturally do not form water-tight compartments. But the major functional life of the village decides its class as well as its plan. The agricultural village is one of the most important basis of the village uplift activities and we shall deal with it separately.

The Pastoral village with its cattle as the villagers' mainstay develops on peculiar lines. Each villager will require plenty of space for impounding his cattle. Such a village will require a hedge or a rampart to protect the living wealth of the village from the attack of carnivorous animals. The houses will also develop features peculiar to their use, such as the provision of safe custody of milk and all the necessities of ghee manufacture. Subsidiary industry of wool, goat-hair and the like will also have its marks. Rural leather industry which bitterly cries for development shall have to be provided for, in the lay-out scheme of the whole pastoral village.

A Forest village is very similar to a pastoral village, but the vocation of the villagers depending on the trade in the forest produce will determine the planning of such a village. Whether the inhabitant of such a village is a primary producer or a mere labourer, will go a great way in deciding its location, as well as, the type of street and the houses in the village.

A village set up on the fringe of a quarry or at the mouth of a mine or the bank of a fishery, will have its own characteristics. Such a vocational village shall have to be designed so as to suit the type of skilled and unskilled lay-out that will congregate at the place. The problem of transport of the products will also have its impress on the design. The future requirements, though usually cared for as a matter of routine in all planning, will here be more necessary. It is to be noted that the probability of the establishment of such villages totally a new, is much more than that of any other type. If the authorities entrusted with the control and development of mining take proper precautions and decide their policy in advance, the ugly, insanitary and ill-planned or rather un-planned slum villages will at least not be repeated near the quarries or mines. The control of such villages is very easy as it can be effected along with the mining control, the only prerequisite being pre-planning and pre-determined forward policy. The District Council and similar local bodies can also take up the initiative and mould the policy of the authorities concerned in such a way that vocational slum villages may no longer crop up.

If ever the dream of the sociological philosopher, who believes in cottage industries as the main supplier of the nation's requirements, becomes a problem of practical politics, a country-wide regional planning for establishing what we may call manufacturing villages will have to be the basis of any achievment in response to the practical repercussions of such a sociological philosophy. In any case, with emphasis on cottage industry and the village as an invariable unit of political and economic planning, a manufacturing village in the centre of a group of villages both conceived as inter-dependent—is surely going to crop up. It will be a wise policy on the part of those who are responsible for the concept of such a sociological order to think out a workable scheme from the point of view of regional planning. The design of such a manufacturing village will depend upon the types of villages that it will serve and on whom it depends. It will also develop as a focal point, on which will depend the moral and material progress of the surrounding rural community.

The prototype or rather an undeveloped version of such a manufacturing village is the commercial or the distributing village of the present times. Its extent and planning depend upon the hinterland over which it distributes. Such villages have developed as distributing centres and their evolution as parasitic community can be seen in their lay-out. An ideal commercial village will go a great way in improving both the economic and social conditions of the surrounding villages which it indirectly controls. The planning of such a village is a problem by itself and will depend upon a great variety of factors.

A religious village is one which grows out of a necessity of supplying the wants of pilgrim population. Such a village ought to be planned with a great deal of care and fore-sight. The defects of such a village tell not only upon the health of the inhabitants of the village itself, but also on that of the pilgrims who spread the disease if imbibed, far and wide. Though the Indian view at the present times is that such villages should continue to exist, yet there dawns on the horizon what we may call a

Politico—Religions village. It will be a great blot on the country if the village belonging to this sub-class is not planned accordingly to the best principles of scientific and systematic planning.

With great emphasis on rural education there is every likelihood of educational villages being put up as brain centres of groups of villages. Of course, great university centres are models which will shape such villages but a through-going planning microscope, if brought to bear on the design of such villages, will go a great way in evolving, an educational village which will educate not only by precept but also by example.

In a voracious world that necessitates the establishment of out-posts, great deal of thought and greater deal of money is generally spent on what we may call the strategic village. Such a village forms part of military engineering and we shall have to leave it here.

The villages can also be classified according to their situation as against use. The positional evaluation of a village is sometimes greater than that of its functional evalution. They may be known by any of the following or similar positions :—

(1) Water side :—(a) River or Stream, (b) Lake, (c) Sea.
(2) Mountain :—(a) Top, (b) Side.
(3) Plain.
(4) Other topographical feature
(5) Road side.
(6) Railway side.
(7) Suburban

The impress on village design on account of its function, is, though firm, too delicate to be easily picked up, while topographical impress is too marked to be missed. The features of a mountain village can easily be recognised as distinct from those of a village on a plain.

The river-side village has its advantages as well as its dis-advantages. The river assures plentiful and easy supply enabling more hygienic conditions, while the village may be endangered by scouring of floods. The drainage facility is great in a river-side village but the possibility of water pollution is equally great. A visitor to a river village will find most of the inhabitants occupied in the river in the early morning— a picture that will not be found in any other type.

A road side village on the other hand will be bustling with traffic presenting its own problems according to the importance of the road and the serviceability of the village to the traffic on that road. The principles of the Safety First Association will have an extensive as well as an intensive field here, the fundamentals whereof will mould the whole lay-out of the village.

Just as a road-side village has a communicational impress, a railway-side village may take the form of a Sarai area. Such a village formulates itself into a miniature emporium and develops peculiarities of its own.

Both these types have to sustain the impact of civilisation brought by the road or the railway line either for good or for bad and they have to accommodate themselves in their development to the changed and ever-changing conditions. Unfortunately the railway and road builders do not take stock of rural requirements as they should and one often sees mutilation of the village-plan both topographical and economical. On the whole, however, a village benefits by its communication facilities, which can give the maximum of benefit to it if there is proper pre-planning and control of development.

A suburban village comes into the category of a communicational village, but due to its proximity to a city it becomes more or less parasitic. Sometimes such a village serves as a dormitory to the city of which it is a suburb.

Over and above the positional effect on the village development, there are many other natural causes, which mould the village design, such as scanty or heavy annual rainfall, extremes of heat or cold, dry or wet air, type of soil and such other climatic, geographical and geological conditions.

The classification by use and position may also be supplemented by one on the basis of population. A classification on such a basis though very easy has a greater influence on the lay-out of the village than any other single functional or positional effect. Both the type and the number of population determine the village design. What may be a necessity for a village with a population of 3000 may be excrescence for a village with say 100.

The following is a list of probable and possible necessities and amenities of an agricultural village.

(1) Main communication, (2) Approach road, (3) Field tracks, (4) Village streets and squares, (5) Culverts and fords, (6) Water: (*a*) *Well*, (*b*) *River*, (*c*) *Lake*, (*i*) *Drinking*, (*ii*) *Washing*, (*iii*) *Bathing*, (*iv*) *Cattle*.

(7) Well platform and lifting arrangement, (8) River ghat, (9) Bathing and washing enclosures and platform, (10) Well drinking arrangement, (11) Cattle trough, (12) Sanitary arrangement: (*a*) *Trenches*, (*b*) *Bore latrine*, (*c*) *Septic Tank*, (*d*) *Vada latrine*, (*e*) *Domestic drainage*, (*f*) *Storm-water drainage*, (13) Community hall, (14) Village square, (15) Children's playing ground, (16) Religious place and guardian deity, (17) School, (18) Cattle pound, (20) Sarai, (21) Uttara or rest house, (22) Dispensary, (23) Library, (24) Post office, (25) Gymnasium, (26) Co-operative institute, (*a*) *Shop*, (*b*) *Godown*, (*c*) *Office*, (27) Commercial and Educational Museum (28) Radio place, (29) Electric station, (30) Place of amusement, (31) Garden, (32) Lighting arrangement, (33) Bus stand, (34) Shady trees, (35) Village common, (36) Khalavad or Winnowing ground, (37) Gondra or Cattle stand, (38) Rampart or hedge, (39) Chabutra or birds' platform, (40) Manure place, (41) Shepherds' enclosure, (42) Experimental farm, (43) Flood protection works, (44) Burial place or burning ghat, (45) Disposal places for corpses, (46) Tanning ground, (47) Weekly bazaar place.

The list is too formidable to be within the reach of every village; yet the village worker can easily find out what is the absolute minimum for his village. He can also decide, what is his optimum and he may well begin working on that line. I should call this list a desideratum. If one takes this as too idealistic I should call it a result of lack of will or the result of peculiar local conditions.

The chief cause of the village remaining unprovided with its legitimate amenities is its brain-drain or the migration of its intelligentia to the urban areas. Unless and until the village is reimbursed with its spiritual and intellectual wealth, its moral and material poverty cannot be wiped out thoroughly and speedily.

To come to a few details: The optimum plot for a cultivator's house may be something like 40' x 60' having at least one street serving it. There are many villages which are satisfied with smaller plots, but these are generally the result of the costliness of land or want of space for expansion. There is also a factor which we may call traditional that decides the size of the plot. For example, if the cultivators are in the habit of keeping extra buffaloes or cows to get additional income from the sale of milk or ghee, the plot required will be bigger. If he is capable of storing his agricultural produce to wait till the market is favourable, his requirement of the size of the plot will be different. If he is poor and cultivates his field by getting bullocks on hire, he is likely to be satisfied with a smaller plot though he may hope for better prospects and feel a future possibility of owning the minimum cattle and thus provide for such a contingency when demanding a plot in the village lay-out. Similarly the plot requirements of a village shop-keeper may be much less but, if he is owning a herd of cattle his requirements will change. Same is the case with the village labourer. As a matter of fact a village planner has to consider the following parent and parasitic population of the village.

(1) Cultivator, (2) Labourer, (3) Carpenter, (4) Black-smith, (5) Potter, (6) Tailor, (7) Shoe-maker, (8) Oil-miller, (9) Carder, (10) Weaver (11) Brass-smith, (12) Carrier, (13) Modi or grain merchant, (14) Broker, (15) Gold-smith, (16) Shepherd, (17) Village priest, (18) Shop-keeper.

The drainage and the street requirements are the determining factors in the shape of the village. As far as possible, the streets should be straight and at right angles to each other. Any other alignment must have its basis on some topographical feature like a promontory or the village tank or the river curve or some preservable monument and the like. The alignment of the streets will also be determined by the approach road from or on a communicational line such as a through road or railway line. The focal centres such as the old village temple or a cluster of important village buildings or a railway station or a well may also decide the alignments. The street arrangement is an important item of village or town planning and is perhaps too technical and surely too elaborate to find a place here.

The width of the street should better be 30'. The optimum is 20' but in no case it should be less than 15'. Of course this is in regard to what we may call neighbourhood lanes. The optimum for the main streets is 40' and minimum 24'. A fully loaded cart requires a good deal of space particularly when it is loaded with bundles of fodder like Juwari and the like. The side drains have to be allowed in order to facilitate the quick removal of storm water. The present system is to provide for drainage on the sides with chamber for the road while in some of the ancient towns and villages we find inverts—a system which avoids scouring of the ground near the house foundations. The practical difficulty in the case of cambered road with side gutters near the house is that the villager protects his foundation by heaping up earth near his plinth with the result that the storm water scours away the road. A sufficient width of the street will take care of all these factors and many more of them. It hardly requires pointing out that the passage ways should be made pucca of the width and the strength in proportion to the duties they have to perform.

Of course it goes without saying that the plan of the house will depend upon those very factors on which the village plan depends. As a matter of fact there will be many more additional factors. The plan of the house of a craftsman will materially differ from that of a cultivator. The shepherd will have peculiar requirements according to his live-stock. The shop-keeper will give his own specifications to suit his trade. The labour houses will have their own problems. In short, the requirements, of each of the classes inhabiting the village will require a careful study, a keen sympathy and a cautious design. The local traditions as well as the types of local materials will considerably affect the house plan.

The requisities of a house of an ordinary cultivator may be given below:—

(1) One or two rooms, (2) Verandah or verandahs, (3) Kitchen, (4) Store, (5) Grain bins, (6) Fodder store. (7).Cattle shed, (8) Implements place, (9) Fuel shed, (10) Bathing platform or enclosure, (11) Latrine arrangements, (12) Manure pit, (13) Courtyard, (14) Main enclosure.

Fixtures and Fitments :—

(1) Shelves, (2) Pegs, (3) Roof pendants, (4) Cup-board, (5) Fire place (6) Kit platform, (7) Water place, (8) Loft, (9) Treasure trough, (10) Niches, (11) Drying bars, (12) Grinding place, (13) Pounding block, (14) Churning fitment, (15) Cattle-tying fixtures, (16) Fodder trough, (17) Family deity's corner, (18) Swing rings, (19) Tulsi pedestal.

This list does not exhaust the whole set of requirements nor can it possibly be made into an absolute minimum. It, however, gives an optimum and it will be a good thing for a village worker to understand the principles of design underlying the above mentioned requirements. The description of these principles will lengthen the paper to a very great extent. The detailing of the same, therefore, becomes out of question here.

A well planned village improvement and extension scheme does not necessarily mean a heavy expenditure. In any case, a half-hearted measure should rather be avoided. Such a measure may in many cases be equally bad, if not worse than having no measure at all. It should always be borne in mind that to tackle such a scheme, one should proceed from the whole to the part. The policy and the plan of the whole village should be chalked out in advance, taking into account both the present and the future requirements.

Regarding the Vidya Mandir Scheme of the Central Provinces, its concept is unassailable. It has diagnosed the disease rightly and aims at applying the remedies accordingly. It supplies a focal point for the brain power which the village needs so badly. It encourages and enforces settlement in the village of those that are responsible for keeping the torch of learning alive in the villages. With the continued emphasis on high ideals, there is no reason why India cannot produce men who will cultivate that Buddhistic or Christian spirit of real mission work that has rightly earned the high esteem of so many generations. Given proper planning and some such nucleus as the Vaidya Mandir to work it out, there is every hope that village movement will render efficient and effective service.

To close in the words of Sir Pattrick Geddes " India is indeed at the outset of a reconstruction movement, say rather, of a reconstructive period. It is no doubt a good beginning to revive domestic industries, but it is a yet better advance to be renewing the villages themselves; and these from agriculture homewards and towards the associated life; a life Co-operative alike towards material efficiency and well-being and towards renewed and advancing culture. So while the Indian people are rightly cheered to have their foremost political leader insisting on the revival of home industries, they will soon be yet more rejoiced to know how their foremost poet—a world poet as well, a creative eductionalist too, making the first Applied Faculty of his University—and a new one for all Universities—that of Village Reconstruction."

Extracts

SILAGE FROM.SUGAR CANE TOPS

A case in point is the almost universal practice of burning off sugar-cane tops and trash each year after the harvest to facilitate ratooning operations or preparation for the next crop. This material is made up largely of the sugar-cane top which is still in the green state at the time of cutting. Quite apart from the loss of potential humus this represents a loss of animal fodder which would be a valuable accessory in time of shortage of natural grazing.

From weighings carried out at the Agricultural College, Queensland during 1940, it was found that the green weight of the cane top at the time of cutting was from one-third to one-half that of the cane cut from the same stem.

A small area of cane at the College, comprising the varieties P. O. J. 2878, Co. 290, P. O. J. 213, Oranboo, and P. O. J. 2725 was consequently harvested and the tops ensiled in July 1939 in a shallow pit silo, 6 feet deep and 12 feet in diameter. A composite sample was chaffed and forwarded to the Agricultural Chemist for analysis. The tops were packed as uniformly as possible in the silo and built 3 feet above the ground. After a few days of settling, more were added and 18 inches of soil placed on top to seal the silo. Considerable sinking took place as the silage settled down and fermentation set in and additional earth had to be placed on top. The temperature taken from the middle of the silo at no time exceeded 95° F.

The silo was opened in may 1940. It was found that there was a wastage of 18 inches around the sides and on top of the silo, but the silage in the middle of the mass was of excellent colour and slightly acid in flavour. Owing to the small size of the silo, the waste presented nearly 50 per cent loss, but with a normal trench silo of 60 to 100 tons capacity the proportionate loss would be much less.

The silage was fed to the dairy cattle and they ate it readily with no harmful effects. A sample was also chaffed and forwarded to the Agricultural Chemist for analysis; he supplied the following figures :—

	Green Tops	Ensilage
	Per cent	Per cent
Moisture	76.1	76.3
Crude Protein	1.8	1.4
Crude Fat	0.30	0.26
Crude Ash	3.10	3.66
Crude Fibre	7.60	8.55
Crude Carbohydrate	11.10	9.86
Lime	0.15	0.09
Phosphoric Acid	0.12	0.10

Unfortunately, no legume was available at the time for ensiling in conjuction with the sugarcane tops. This would undoubtedly have provided a better feeding mixture. However, it was sufficiently demonstrated that cane-top ensilage can be easily made.—*(Queensland Agricultural Journal, Vol LV, Part 5, 1st May, 1941.*

POISONING "WEED TREES" AND UNDER GROWTH

The advantages of arsenic pentoxide as a plant poison, as an alternative to sodium arsenite, which was formerly used, have received full recognition in recent years. With sodium arsenite, the preparation of the solution involved the mixing of either washing soda or caustic soda with the white arsenious oxide to convert it into an active plant poison agent. Arsenic pentoxide, on the other hand, is soluble in cold water, and no time or labour is wasted in its preparation. For the eradication of practically all species of undergrowth and green timber it is both cheap and effective.

As arsenic pentoxide has a corrosive action on iron and tin containers, either wooden, copper, or lead-coated vessels must be used. The day's mixture should be prepared overnight in order to allow it to dissolve fully. The liquid, which should be practically colourless, must be stirred before using. If it is to be used as a spray, half a pint of molasses should be added as a sticker, or spreader, per gallon of poison. The most effective mixture is 2 lb. of arsenic pentoxide per gallon of water. For spraying tender foliage or suckers, ½ lb. per gallon is sufficient.

Two operators are necessary in dealing with undergrowth, one using a brush hook and the other following closely with the swab or spray, according to the area to be treated. The cuts should be made as near to the ground level as possible. Small areas up to several acres can be most economically treated by swabbing. Large areas require a quicker method, and for this purpose a lead-coated knapsack spray pump is recommended.

Another method is to cut the undergrowth and after allowing it time to dry, burn it. A new growth will soon appear, but before these shoots attain a length of twelve inches they should be sprayed with the weaker mixture. The shoots are easily killed, and enough poison is absorbed to kill the roots and stump.

Tall timber can be effectively poisoned by frilling a process somewhat similar to ringbarking. The only difference is that the cuts are downwards deep into the wood, and the bark is not removed· The mixture (2 lb. per gallon) is poured into the open cut. Most trees are easily killed in this way, but care must be taken with gums and ti-trees to prevent suckering

To obtain the best results, and reduce suckering to a minimum, poisoning should be performed in the late autumn or early winter when the sap flow is less vigorous. As arsenic pentoxide is a very dangerous poison, great care must be exercised in handling it, and precaution must be taken to prevent stock having access to it.—(*Queensland Agricultural Jour., Vol. LV, Part 5, 1 May, 1941*).

THE "TOPATO"

The crossing of potatoes with tomatoes for the production of a crop above and below ground from the one plant has long been a stock joke at show dinners, but it can be done and has been done, according to a report by research workers in the United States. This is how they did it. Tomato tops were successfully grafted on to potato roots and, in due course, the top of the plant produced tomatoes and the roots potatoes. The potato produced is starchless, and, the report says, " hailed as a boon to stout women who like potatoes, but shun them for fear of excess poundage." The name of the new product is " topato ".—(*Queensland Agricultural Journal, Vol. LV, Part 5, 1 May 1941*).

INDIAN VEGETABLE OIL AS FUEL FOR DIESEL ENGINES

The annual production of vegetable oils in India is about eight million tons. Although at present the market prices of vegetable oils are in general higher than that of mineral Diesel oils, in certain localities, particularly the non-edible oils are available at fairly cheap rates, and it is quite probable that at a not too distant future, the relative prices of the vegetable and mineral oils may be reversed. It is therefore of great national importance to investigate the utilisation of vegetable oils as Diesel engine fuels. The results obtained by the Indian Research Bureau indicate that most of the vegetable oils may be successfully employed as Diesel fuels (Bull. Ind. Res. Bureau, 1940 No. 19 by H. D. Chowdhury, S. N. Mukerji, J. S. Agarwal and Lal C. Verman). Some do not require any modification in the engine except minor adjustments; such oils include groundnut oil, cotton seed oil, and rape seed oil. Cotton seed oil gives an exceptional perforance in that its consumption is definitely less than that of mineral oils, and its efficiency appreciably higher, while the power output is equal to that obtained in the case of mineral oil.—*(Current Science, Vol. 10, No. 5, May 1941).*

BRIEF DESCRIPTIONS OF THE PRINCIPAL INDIAN BREEDS OF CATTLE, THEIR HOMES AND THEIR CHARACTERISTICS

(From Indian Information Feb. 15, 1941)

Alambadi.—This is a type of hill cattle bred in the North-Salem and North Coimbatore Districts of the Madras Presidency adjoining the Mysore State. The breed is very similar to the Mysore breed. The cattle graze in the large forests. The male stock are generally sold as yearlings at big fairs to ryots who rear and sell them as work cattle. They are very active and hardy animals and can live on scanty rations. They are in good demand for cart and mhote work. This is purely a draught breed. The cows are poor milkers.

Bargur.—This breed of cattle are bred extensively in the Barghur Hills in Coimbatore District of the Madras Presidency.

They resemble the Mysore type of cattle but are smaller and more compact. The bulging forehead is not so prominent as that of the Mysore. They are very fiery and restive and difficult to train. For spirit, power of endurance and speed in trotting they are said to be unsurpassed. The chief colours are red, grey and white, red with white spots and white with red spots. The cows are very poor milkers.

Bhagnari.—The home of this breed is the Bhag territory, north of Jacobabad, Baluchistan and the adjoining areas of Sind. This is mainly a treeless, undulating country subject to climatic extremes, and cultivation is largely from flood water received from the Nari river.

The cows are reputed to be very fair milkers and selected animals have given quite good yields.

Two types of Bhagnari cattle are recognised: a small type bred in the lower Nari Valley around Jacobabad and a larger type bred in the upper Nari Valley as far north as Sibi.

Deoni.—The breed is mainly confined to the north-western and western portions of the Nizam's Dominions and appears to be allied to the Dangi cattle of Bombay Province.

The bullocks are good work-animals for heavy cultivation, while the cows are reported to be the best milkers in the Nizam's Dominions. In general, the Deoni resembles the Gir breed of Kathiawar to a considerable extent but there is no doubt that it has other blood in its composition and the conditions under which it is bred and reared are very different and it has developed along somewhat different lines.

Dhanni.—The cattle of this breed are moderate-sized, compact, active, work-animals and are bred in considerable numbers in the Attock, Rawalpindi and Jhelum areas of the Punjab and in North-West Frontier Province.

They are not big animals but are very active and compact and are much prized as fast-moving plough-cattle but the cows are on whole poor milkers.

Gaolao.—This is the most important breed of the Central Provinces and is seen at its best in Wardha and Chindwara Districts.

Because of inadequate feeding when young, the catte are generally light of build. Cows of this breed are considered to the good milkers and the bullocks make useful work-cattle if well developed.

Gir.—The home of the Gir cattle is the Gir forest of south Kathiawar and they are found in their purest state in this area. Cattle of Gir blood are however met with over a wide area including large portions of western Rajputana and of Baroda and the northern sections of Bombay Province.

Owing to the custom of cattle-owners in some of these areas to move their cattle over a wide range, in search of suitable grazing, large infusion of Gir blood can be detected in various breeds in surrounding tracts.

Gir cows are good milkers as a whole, but vary a great deal in this respect. The bullocks if well developed are heavy powerful animals but are slow and lethargic in movement compared with some of the fast trotting breeds. They are however, extensively used as draught animals and, in addition, are reputed to be the best beef-cattle in India.

Hallikar.—The Hallikar breed is mainly produced in the Tumkur, Hassan and Mysore districts of Mysore State. It represents a very definite type, varieties of which, differing in general type only slightly from each other, are found throughout Mysore territory and in certain areas of the neighbouring provinces and States.

The head and horns of these cattle are very characteristic and are quite different from those of any other type. The most striking feature is the prominent forehead, usually furrowed in the middle, with a long face tapering towards the muffle and horns which emerge near each other from the top of the poll and are carried backwards in a graceful sweep on each side of the neck and then curve slightly up-wards to terminate in the sharp points which are a feature of the horns of cattle of this type. Similar horns are typical of a wide range of south-Indian cattle and indicate a distinct basic type which must have existed from prehistoric times in Mysore and the surrounding territory.

Hariana.—Hariana cattle are bred particularly in the Rohtak, Hissar, Karnal and Gurgaon Districts of the Punjab and in Delhi Province whence, every year, large numbers are exported to Calcutta and other large cities for milk production, but animals of the Hariana type are produced, over a wide area to the south of this, particularly in the east. United Provinces, Alwar and Bharatpur areas where like the pure Hariana they are valued as powerful work-animals which at the same time are capable of producing a fair amount of milk. Hariana bullocks are particularly good work-animals for rapid ploughing and road transport.

Hissar-Hansi.—As the name indicates, this breed has its home around Hansi in the Hissar Districts, and is found in large numbers in that district as well as in the adjacent areas of Gurgaon and Delhi Districts, where these animals are extensively used for draught purposes.

These animals are generally similar to the Hariana, but are stronger and are more heavily built with comparatively thick long curved horns, large loosely hanging ears, heavy feet and slightly pendulous sheath. The characteristic bony prominence found at the centre of the poll of Hariana cattle is usually absent in this breed. They are distinctly draught animals and are mostly used for that purpose. They are comparatively poor milkers.

Kangayam.—These cattle are bred in the south and south-east taluks of Coimbatore in Madras Presidency, where a long established herd, maintained by the Pattigar of Palayakottai, is one of the most important herds of any breed of cattle in India. These cattle conform largely to the Mysore type but there is evidence of the blood of the grey-white cattle of the north in their composition. Kangayam cattle have, however, been scientifically bred and carefully fed through many generations and are a very well-fixed breed of moderate-sized but powerful draught cattle. They are exported in large numbers for work in south India and Ceylon and are strong, active work-animals, particularly economical to maintain, but the cows are generally poor milkers. They are of very good constitution and are said to last from ten to twelve years in work.

(To be continued in the next issue).

RESOLUTION OF THE GOVERNMENT OF THE CENTRAL PROVINCES AND BERAR ON THE WORKING OF THE DEPARTMENT OF AGRICULTURE DURING THE YEAR ENDING THE 31st. MARCH 1941

The Agriculture Department has completed another successful year. The agricultural conditions prevailing during the year were peculiar. On the whole they were more favourable to the cotton tract than to the wheat and rice tracts. In fact in the Chhattisgarh Division and in the Jubbulpore and Mandla Districts of the Jubbulpore Division it was necessary to organise some measures of relief.

2. In the field of agricultural education Nagpur University has gone a step further in encouraging post-graduate study by instituting a Ph. D. degree in Agriculture. The popularity of the College of Agriculture in the Province continues to grow and the results achieved are highly satisfactory.

3. In the field of research and experimental work also steady progress has been maintained. It has been established that grape fruit can be grown successfully in the plateau districts. One of the most important research schemes in the province at this time is the rice research scheme located at Labhandi farm in the Raipur District. The Department has evolved 14 improved varieties of paddy to suit the varying requirements of different tracts and people. Hybrids bred for the elimination of wild rice (karga) are almost fixed and, at the lowest computation, it is expected

that they would be able to save loss aggregating about Rs. 21 lakhs in the three districts of the old Chhattisgarh Division. Research continues into methods of fighting rust which is the great enemy of the wheat crop. Two new rust resistant varieties, Nos. 3712 and 3729, are being tried out and the Mycological Department is making experiments to discover methods for fighting the infestation. A new wheat research scheme which the Imperial Council of Agricultural Research is helping to finance came into force soon after the close of the year.

4. The research into cotton has now been divided into separate branches for the Central Provinces and Berar. Government is pleased to note that there has been increase in the popularity of verum cotton, the area under which has risen from 16,000 acres in 1937—38 to nearly 2.71 lakhs acres in the year under report. It is also satisfactory that verum 434, commanded a premium of Rs. 42-13-0 over Broach and Rs. 76 over Oomra, and that the decline in prices of cotton caused by the war was much less steep for verum than that for Oomra. Another instance of the value of agricultural research to the rural economy of the province is furnished by the fact that it is estimated that the extra income to agriculturists from verum 434 alone amounted to about Rs. 15.5 lakhs.

5. The Department carried on its usual administrative and propaganda activities to bring home the results of research to the agriculturists. In this connection it is interesting to note that a scheme for a new method of propaganda and for promoting an interest in mixed farming has been evolved with the aid of the Imperial Council of Agricultural Research and the Indian Central Cotton Committee and will soon be put into operation. 5.33 lakhs maunds of pure seed were distributed during the year and the estimated area under improved seed increased from 20.88 lakhs acres to 22.90 lakhs acres. This seed is in addition to over 35 lakhs of sugar-canes and nearly one and a quarter lakhs of fruit seedlings distributed for planting during the year. Implements to the value of over Rs. 1½ lakhs were sold. A decline of about Rs. 30,000 is attributable to an increase in the price of the implements and unsatisfactory crops in some tracts.

6. The Agriculture Department did its part in the measures for fighting the conditions created by the failure of crops in the Chhattisgarh Division. All the assistance possible was rendered to the officers of the Revenue Department in estimating the out-turn of crops and making enquiries into the requirements of the people. Seed worth Rs. 90,000 was purchased in the Drug District alone with the aid of the officers of the Agriculture Department and similar action, though on a smaller scale, was taken in some other districts.

7. A scheme has also been evolved for planting ornamental trees on road-sides and in compounds in the Nagpur town, for which purpose a special fund has been organized to which Government and the people are expected to contribute.

8. The thanks of the Povincial Government are due to the Imperial Council of Agricultural Research and the Indian Central Cotton Committee for their continued support. Government also records its appreciation of the continued devotion to duty and industry of the Director of Agriculture, Mr. J. C. Mc Dougall, and his staff.—*(Extract from the Central Provinces and Berar Gazette, dated the 29th. August, 1941).*

College and Hostel Notes

The College session commenced on the 14th of June 1941. The rush for admission to the College was very great. Our Principal, E. A. H. Churchill, Esq., I. A. S., gave an illuminating address to the new entrants. He laid great stress on the necessity of maintaining strict discipline by every student. He advised them to look to their College life, mainly, as a period of training, in qualities, which when developed, would stand them in good stead in their after-life.

Two notable changes in the College staff have taken place. J. F. Dastur, Esq., M. Sc., D. I. C., I. A. S., Professor of Mycology has gone on leave and R. P. Asthana, Esq., M. Sc., Ph. D., D. I. C., has succeeded him. K. G. Joshi, Esq., M. Sc. (Agr.), Demonstrator in Agriculture has gone on study leave. He has joined the Indian Institute of Science, Bangalore, for conducting research in Bio-Chemistry, leading to the Ph. D. degree. We wish him every success.

The College elections which were contested with great enthusiasm evinced a remarkable spirit of service on the part of the different candidates. The following is the result.

General Secretary for College	... Mr. D. D. Shukla	III year.
„ Sports	... „ Laxman Pande	„
Secretary for Hockey	... „ C. S. S. Mudaliar	„
„ Foot-ball	... „ G. T. Saoji	„
„ Volley-ball	... „ B. L. Nayak	„
„ Tennis	... „ Ajit Singh	IV year.

Mr. P. S. Parsai, III year, has been nominated as the Librarian for the Hostel Library.

ASSOCIATION OF THE QUIET HOUR

Mr. P. S. Parsai III year, and Mr. G. P. Mishra, II year have been nominated, respectively, as Secretary and Joint-Secretary.

Three meetings have been held till now under the auspices of the above Association.

In the first meeting, the Principal addressed the students and explained to them the aims and objects of the Society. In the second meeting Brahmachari Madhavaprakash of Govardhan Math, Puri, spoke on "Brahmacharya" and the duties and ideals of students. The third meeting received Mr. Banerji, a World Tourist, who gave an interesting account of his travels in the Oriental Countries.

A special condolence meeting of the students and the staff was held on the 10th August 1941 to mourn the loss of India's world famous Poet Rabindranath Tagore. After the Principal's opening remarks Swami Bhaskareshwarananda of the Ramkrishna Ashram paid tribute and spoke on the life and work of the great poet.

Our Hostel is very happy, mainly due to the unfailing guidance and sympathy of our Principal, Mr. Churchill and our Hostel Wardens, Messrs S. K. Mishra and K. S. S. Iyer, to whom we are deeply grateful.

RETIREMENT OF OFFICERS

Within the last few months three of our veteran officers, S. G. Mutkekar, Esq., B. Ag. (Bom.), M. Sc (Mass.) I. A. S., Deputy Director of Agriculture, Western Circle; Rao Bahadur G. K. Kelkar, B. Ag., Deputy Director of Agriculture, Southern Circle; and J. F. Dastur, Esq., M. Sc., D. I. C., I. A. S., Mycologist to the Government, Central Provinces and Berar, have gone on leave and are likely to retire soon.

Mr. Mutkekar has to his credit a long and meritorious service in this department, which proved to be extremely valuable to the agriculturists of Berar, with whom he was associated for a long time. He brought with him the benefit of his study and experiences in American agriculture and dairying. The survey of finance and marketing of cotton in some selected villages in

Berar, conducted by him in 1925—26, is a valuable contribution to the economic knowledge of our Province. We wish him a long life and a well-earned rest.

Rao Bahadur Kelkar was a very enthusiastic officer with whom the interests of the agriculturists were above every thing. The economic development of the tract entrusted to him engaged his attention very prominently. His efforts in developing orange cultivation in the Nagpur tract and in evolving an orderly marketing system, by organizing the Nagpur Orange Growers' Association, will ever be remembered. We wish him a long and happy retired life.

To Mr. J. F. Dastur, our College owes a great deal of gratitude. He was the Mycologist to the Government and Professor of Mycology, and has also officiated as Principal of the College for periods of varying length. As Principal, the first thought in his mind was the welfare of the students. The splendid courage and swiftness displayed by him in the immediate resumption of the usual working of the College, after the unhappy incident of the collapse of the College porch, won for him great admiration. In the sports and the social functions of the College he always took a leading part. His scientific achievements in the field of plant-pathology are very widely known. After a hard life, a patient study and invaluable research, he now retires to a quiet and contented life. Our good wishes are with him.

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We offer our congratulations to Mr. R. P. Asthana, M. Sc., Ph. D., D. I. C., on his appointment as Mycologist to the Government, Central Provinces and Berar. In him, we have an eminent scientist of considerable practical experience and a very enthusiastic professor. We wish him every success in his new appointment.

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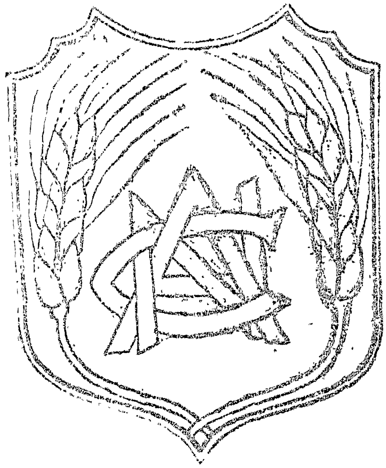

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Editorial

THE LOCUSTS AGAIN !

After about a decade of quiescence the locust menace has again asserted itself and is now threatening to be of unparalled magnitude. The last invasion of India occurred during the years 1926-31 and the Government of India realized that unless systematic investigations were carried out into the study of bionomics and control of the pest, a really effective solution of this periodically devastating pest would not be found. Thereupon, a locust research scheme was financed by the Imperial Council of Agricultural Research from December 1930, which succeeded in obtaining very valuable information. The locust warning organization has since then been formed and the entire work on the problem of locusts is now under the Imperial Entomologist.

During the course of these investigations considerable work has been done on the life-history, habits, bionomics and the control of the pest. Control measures aimed at destruction of the pest in egg, hopper, or adult stage are devised, and if systematically carried out on a co-operative basis, these are bound to be very effective in checking the depredations caused by this pest.

The present position is that, locusts have invaded practically all the provinces of India, and in Baluchistan, North-West

Frontier Province, Sind, Rajputana, the Punjab and the Central India States, the danger is formidable, as breeding is in progress. During the months of September and October, locust swarms flew over all these provinces and also moved on to the Central Provinces. In the Central Provinces a large swarm entered Harda Tahsil from Bhopal side on 21st September 1941. The next morning it moved towards Sohagpur from where it divided into three branches. One small branch crossed the Nerbudda, another small branch headed towards Chhindwara, and the third, which was the main swarm, passed through Narsinghpur, Lakhanadon, Nainpur, Baihar, Gondia, Nagpur, Wardha, Amraoti, Akola, Daryapur, Malkapur and finally entered the Hyderabad State and reached as far as the Bellary District in the Madras Presidency. The problem is thus no longer of a local character, but is inter-provincial and even inter-national. In Sind, the problem is most acute and Government proposes to spend Rs. 2 lakhs in fighting the pest. The Central Government is also rendering financial and technical aid to the Central India States.

It is true that the most effective check can be introduced at the breeding grounds by destroying the eggs by ploughing or digging them up, and by killing the hoppers by trenching them. All attempts in this direction are being made by the various provincial Governments, as also the Central Government and there is every hope that this incipient danger will be greatly minimized. In the Central Provinces and Berar, the main danger is from the flying locusts as the soil conditions are not favourable to egg-laying by the insect. Mechanical methods of destruction, are advocated to the general public, which when practised, would considerably reduce the number. The Department of Agriculture is also equipped with material for killing the locust by poison baits, flame-throwers etc. In dealing with a major pest like this, an active co-operation of the officials and non-officials promises to go a long way in securing the protection of crops.

THE LATE Mr. S. B. GOKHALE

We learn with deep regret the sad demise of Mr. S. B. Gokhale, B. A., LL.B., Advocate, Nagpur, on 18th November 1941. This has removed from our province a great enthusiast of agricultural improvement and a keen advocate of agricultural education. His association with the development of agricultural education and particularly with the progress of this College and the Anglo Hindi Agricultural Middle School, Powarkhera, can never be forgotten. From time to time, he has freely mixed with the students, taking them to villages to give them an insight into rural life, and has given them many an illuminating talk on agricultural topics. The graduates with the " green badges " are indebted to him for his effort in creating openings for them in the Revenue and Co-operative Services. His numerous contributions on agricultural and tenancy problems have been well received. In him, this College has lost a true, sincere and devoted friend. May his soul rest in peace !

Original Articles

THE NATURE OF CHEMICAL WEATHERING OF TRAP ROCK IN NAGPUR

BY MR. K. G. JOSHI, M. Sc. (Agr.)

(Lecturer, College of Agriculture, Nagpur)

The rock minerals are largely composed of complex alumino-silicates. In the presence of water and carbon dioxide they undergo slight decomposition giving an alkaline solution containing sodium and potassium carbonates ; forming also calcium and magnesium carbonates, insoluble silicates (clay) and free silica. This is a general feature of chemical weathering of rocks.

The trap rock consists of felspar, olivine, augite and other minerals (Wadia : Geology of India) which are largely susceptible to chemical weathering being silicates of aluminium, iron, alkali earths of alkali metals.

With a view to studying the chemical changes which the rock undergoes in the process of weathering, samples of fresh rock and weathered rock materials were collected. The rock from which the samples for analyses were obtained is situated to the south west of Nagpur, near the Telankheri tank. In the interior of its mass, the rock is hard, fresh and compact, without traces of decomposition products, other than some infiltration products of quartz, principally in the form of agate, and calcite. Chips of fresh rock were obtained from the quarry work, and were washed and pounded. This has been referred to as sample No. 1 (fresh rock) in this paper. In the lower strata of the exposed cutting of the rock, a partially decomposed weathered material with greenish tinge is observed. Being buried in debris, it was supposed that this material has not undergone much weathering and hence the sample from this material was classed as the first stage in the weathering of the rock. This material containing green amygdaloidal crystals represents sample No. 2 (Green Murum). At the exposed surface of the rock where boulder formation takes place, the character of the rock changes suddenly, becoming brown or greenish brown and friable though still retaining its form and easily recognisable trappean appearance, which can be confirmed by the inner hard mass of the boulder. This partially decomposed exfoliating material represents the second stage in the weathering of the rock and has been designated sample No. 3 (Exfoliating structure). The final stage of decomposition is represented by sample No. 4 (Red Murum) in which the rock is converted into sand and gravel, which becomes more and more soil-like and actually turns into soil after further disintegration and admixture with organic matter. This is the red murum that forms a layer of some feet over the rock.

A weighed quantity of these samples was mixed thoroughly with five times the quantity of sodium carbonate in an agate mortar, transferred to a nickel dish and fused over blow pipe. Silica, sesquioxides and calcium were estimated in the acid solution of this fused material. The following table gives the analysis of the rock and the various products of its weathering. Losses of different constituents from the entire rock mass during weathering processes have also been worked out on the alumina basis and included in the table.

The principle of expressing the results of analysis of the final product of weathering on the alumina basis for calculating the losses in weathering is outlined below. Minerals consisting essentially of silicates of alumina and magnesia under majority of climatic conditions are less liable to decomposition than those containing considerable proportions of iron protoxide or of lime, for the reason that the first named scarcely, if at all, are affected by the ordinary atmospheric agents of weathering. Bischof (referred by Merrill: Rock weathering and soils page 219) mentions that the silicate of alumina is not at all affected by carbonic acid. Researches of Muller and Merrill, however disprove this. Though the latter authors consider that aluminium silicates are to some extent affected by atmospheric agents, still for general purposes aluminium silicates may be taken to resist their action (more particularly so in the tropical regions of intermittent rainfall), and hence using alumina basis losses of other constituents should be calculated. These losses are calculated from the difference in the percentage of the constituents in the fresh rock and that in the final product of weathering, after converting the analytical figures of the latter on the basis of alumina present in the fresh rock.

TABLE 1

*Showing the nature of chemical weathering in the trap rock**

	Samples							
	1	2	3	4				
	Fresh rock.	Green murum 1st stage of weathering.	Exfoliating structure 2nd stage of weathering.	Red murum final stage of weathering.	Red murum on Alumina basis.	Losses from the entire rock by weathering.	% of constituent not lost in weathering.	% of constituent lost in weathering.
Column 1	2	3	4	5	6	7	8	9
% SiO_2	51.70	50.60	47.06	40.40	37.60	14.10	71.68	28.32
% Al_2O_3	17.82	15.02	17.20	19.50	...	...	...	...
% Fe_2O_3	14.19	14.03	15.60	17.60	...	...	...	...
% CaO	10.10	8.59	7.91	5.10	4.74	5.36	46.93	53.07
% loss on ignition	0.0	...	...	11.0	...	...	...	...
% difference	6.19	11.76	12.23	5.40	5.02	1.17	81.09	18.91
	100.00	100.00	100.00	100.00	...	20.63	...	...

Use of the following formulae has been made in getting columns 6,7,8 and 9 :—

Column 6 = $\frac{B.A.}{C}$, where A=percentage of the constituent in the red murum B=percentage of alumina in the fresh rock and C=percentage of alumina in the red murum.

Column 7=Column 2—Column 6.

Column 8= $\frac{100 \cdot A}{B}$, where A=percentage of constituent in the red murum and B=percentage of constituent in the fresh rock.

Column 9=100—Column 8.

It is seen from the above table that there is a gradual but definite loss of silica and calcium during the process of weathering; potassium and sodium not being determined are not considered here. The loss of silica amounts to about 28% and that of calcium to 53% of the amount of these ingredients present in the fresh rock. An apparent increase in the sesquioxide is noted in the red murum. As a matter of fact there may be little or no loss of them and perhaps due to oxidation and hydration an increase in their amount is noted.

The loss of silica under these climatic conditions could be easily explained. The silicic acid is relatively more soluble in rain water but the presence of dissolved salts or humified organic materials decreases its solubility. Iron hydroxide and alumina, on the contrary, are insoluble in pure water and in salt solutions, but go into solution as soon as water contains humified organic matter or strong acids. Under the tropical climatic conditions, due to high temperature condition and consequent rapid oxidation of organic matter, rain water does not contain any appreciable amount of humified organic matter. The conditions, therefore, are more favourable for the loss of silica than for the loss of sesquioxides.

It is observed that the total losses during weathering sustained by the rock are of the order of about 20%. It has been mentioned by Merrill (Merrill: Rock weathering and soils, page 212), that in the case of crystalline rocks this loss, so far shown by the available analytical data and calculations of different workers, rarely exceeds 60% of the entire rock mass.

It will be further interesting to study the molecular silica-alumina and silica-sesquioxide ratios as affected by weathering processes. Russell (Soil conditions and plant growth, 1932, page 154) mentions that the molecular silica-alumina ratio in the fresh rock is 6 or thereabouts and under tropical climates colloidal weathered product tends to have a ratio 4 to 2. Very low ratios indicate laterisation. In the present investigation ratios in the colloidal material has not been determined. These ratios on the material as a whole are given in table 2 below.

Results given in this table show that the green murum which has been regarded to be the first stage in weathering of the rock, shows a higher silica-alumina or sesquioxide ratio than even the fresh rock. It is therefore doubtful whether it represents the first stage in weathering of the rock. On the other hand, the exfoliating structure of the boulder has slightly lower silica-alumina ratio than the fresh rock. In chemical composition, moreover, this material is very much similar to the fresh rock. It could be inferred therefore that this material may be regarded as the initial stage in the weathering of the rock. In the red murum the silica-alumina and also the silica-sesquioxide ratios have been lowered considerably showing thereby that it has undergone decomposition to a fairly great extent.

TABLE 2

Showing the molecular silica-alumina and silica-sesquioxide ratios in different stages of weathering

Weathering stages	$\frac{SiO_2}{Al_2O_3}$	$\frac{SiO_2}{Al_2O_3 + Fe_2O_3}$
Fresh rock	4.92	3.26
Green murum	5.71	3.59
Exfoliating structure	4.68	2.95
Red murum	3.51	2.23

SUMMARY

Samples of fresh rock and three partially decomposed materials in different stages of weathering were analysed. It was observed that on the whole the rock sustains a loss of about 20% during weathering. The loss of the constituent silica is about 28% and that of calcium about 53%. The silica-alumina, as well as the silica sesquioxide ratios, are lowered from 4.92 to 3.51 and 3.26 to 2.23 respectively in weathering.

A STUDY OF THE FAMILY BUDGETS OF 6 TENANT FAMILIES OF VILLAGE DHAMARIA

Tahsil ... Seoni Malwa
District ... Hoshangabad
(Period :—1st June 1939 to 31st May 1940)

By Mr. S. L. Patni, B. Sc. (Agr.)
(*Agricultural Assistant, Tharsa Farm*)

Introduction.—Cost accounts only give income and expenditure of the cultivator from the point of view of cultivation but do not deal with the domestic expenses of a cultivator's family, nor do they give the income and expenditure accounts in connection with the milch cattle and the young stock that the cultivator usually keeps along with the bullocks. Cultivation work is carried on as a family concern and nearly every member of the family contributes some share to it. So it is clear that the study of family budgets is needed to show how the tenant families manage to live and to find out how they should effect any change to improve their financial condition.

The cultivators of the above mentioned villages may be roughly classified into two main groups.

(1) Cultivators having *one* pair of bullocks.

(2) Cultivators having *two* pairs of bullocks.

The cultivators cultivate their own lands and also take lands on lease or Batai. Some cultivators are only sub-tenants. To know the income and expenditure of the cultivators of the village, three cultivators representing each group are taken into account.

The following table shows the number of members in each family.

Tenant	Adults above 16 years		Adolescents 10 to 16 years		Children below 10 years	Total
	Male	Female	Male	Female		
A	3	4	...	1	2	10
B	3	2	...	...	...	5
C	1	2	1	...	2	6
D	1	1	...	...	1	3
E	3	3	1	...	2	9
F	2	1	...	...	2	5
Average	2.16	2.16	.33	.16	1.5	6.33

The first three families belong to group (2) having two pairs of bullocks. The last three families belong to group (1) having one pair of bullocks. The last one F is a sub-tenant family.

Family Budgets.—The family budgets of these tenants will be studied under two heads (a) Income and (b) Expenditure.

The income of the cultivator can be divided into two main heads.

(1) **Agricultural income.**—This means the saving from the cultivation of land obtained after deducting the expenditure on various items of cultivation from the gross income i. e. Gross income—Expenditure = Net income.

(2) **Subsidiary income.**—This includes the income got by subsidiary industries e. g. income from milch cattle and income from wages got for the labour done on other's farm.

Agricultural income can be divided into two groups—

(1) The income derived from his own lands or lands taken on lease.

(2) The income derived from the land cultivated in Batai.

The agricultural income of different families is as given in the table.

Family	Agricultural Income			Batai			Total		
	Own lands and land on Lease								
	Rs.	as.	ps.	Rs.	as.	ps.	Rs.	as.	ps.
A	54	10	6	76	1	6	130	12	0
B	232	12	9	82	11	10	315	8	7
C	430	0	2		...		430	0	2
D	96	3	0	22	9	3	118	12	3
E	72	1	6	43	11	9	115	13	3
F	13	10	0	38	0	9	51	10	9

It is interesting to note the income of families 'F' and 'C'.

Income of 'F' is very low because he is a sub-tenant, while income of 'C' is very high as he mostly cultivates his own land.

The subsidiary income is divided into two main heads :—

(1) Cattle income

(2) Labour income

Cattle income is the income got from milk and milk products after deducting the expenditure on milch cattle.

The second subsidiary income is from wages got for doing work on other's farm named as labour income. In the spare time the farmer and his family go for work on other's farm. In some cases when there are more working members in the family than required for cultivation of home land, some of its members engage themselves as servants. Well-to-do cultivators do not work as hired labourers.

The subsidiary income of different families is given in the following table.

Family	Cattle income			Labour income			Total		
	Rs.	as.	ps.	Rs.	as.	ps.	Rs.	as.	ps.
A	89	10	0	131	0	0	220	10	0
B	5	5	0	37	14	0	43	3	0
C	49	11	3		...		49	11	3
D	52	4	9		...		52	4	9
E	18	8	6	169	6	0	187	14	6
F		...		81	7	0	81	7	0

The total income of different families is as given below :—

Families	Agricultural income			Subsidiary income			Total		
A	130	12	0	220	10	0	351	6	0
B	315	8	7	43	3	0	358	11	7
C	430	0	2	49	11	3	479	11	5
D	118	12	3	52	4	9	171	1	0
E	115	13	3	187	14	6	303	11	9
F	51	10	9	81	7	0	133	1	9

Expenditure means the household expense which is analysed under the following main heads :—

(1) Housing, (2) Food, (3) Clothing, (4) Fuel, (5) Light, (6) Religion and amusement, (7) Social, (8) Miscellaneous.

(1) **Housing.**—This chiefly includes the cost of repairs and upkeep of the houses.

(2) **Food.**—This is the most important item of expenditure. It is further sub-divided into the following heads :—

(1) Wheat, (2) Maize, (3) Juar, (4) Milk and milk products, (5) Sugar and Gur, (6) Rice, (7) Pulses, (8) Oil, (9) Vegetables, (10) Fruits, (11) Salt, (12) Miscellaneous.

The diet of the villagers consists of wheat, maize or juar "Roti" (Chapati) or Dalia (A fluid preparation from coarse wheat or maize flour, boiled, salted and spiced) pulses, vegetables and occasionally ghee, butter-milk and milk. Rice, puri and some sweet preparations and other special dishes are also prepared occasionally either to treat guests or at the time of festivals. Wheat is mostly eaten as Roti but in times of scarcity 'Dalia' is used. When there is no wheat, maize or juar is used instead, both as 'Chapati' and 'Dalia'. This occurs in winter months.

Food forms 73.53% of the total expenses. The proportion of expenditure on different items of food is given in the following table:—

ARTICLES	%
Wheat ...	52
Milk and milk products ...	21.52
Sugar ...	5.31
Pulses ...	4.73
Rice ...	3.82
Maize ...	3.52
Miscellaneous ...	2.72
Juar ...	1.82
Oil ...	1.74
Vegetables ...	1.51
Salt ...	0.70
Fruits ...	0.61

(3) **Clothing.**—This is the second important item of expense. Dresses can be divided into 3 types.

(1) General purpose clothes or clothes used every day.
(2) Clothes used on special occasions.
(3, Bedding, covering etc.

All the things are purchased from the market except the shoes which are purchased from the local shoe-maker.

(4) **Fuel.**—There is absolutely no expense under this item except in few cases in which the farmers bring fuel from Government Forests. They use dung cakes and other things which the farmers get on their fields.

(5) **Light.**—Unrefined (red oil) or refined kerosene oil (white oil) is used. The expense under this item is not much as the farmers do not keep the 'Chimney' (a kind of lamp without glass chimney) burning for the whole night.

(6) **Religion and Amusement.**—Expenditure under this consists of contribution given to temples and also includes the cost of 'Prasad' distributed sometimes by the farmers. There are no separate amusements except at fairs and on festivals. When the farmers are free they read religious books and also sing prayers to the accompaniment of local musical instruments.

(7) **Social.**—This item includes the expenses incurred at ceremonials like marriages, betrothal, births and mourning. As a rule relatively heavy amounts are spent on these. It also includes presents in the form of clothes and other articles to relatives on these occasions.

(8) **Miscellaneous.**—Under this are included all the expenses which are not included in the items given above, such as on 'Karnins' and tobacco.

The table showing the proportion of the various items of expenditure is given below :—

Items of expenditure	%
Food	73.53
Clothing	18.06
Miscellaneous	3.41
Housing	2.05
Social	1.76
Religion and amusement	0.56
Lighting	0.63

The following table shows the total expenditure of different families.

Families	Expenditure		
	Rs.	As.	Ps.
A	347	9	3
B	351	2	9
C	363	4	9
D	166	13	0
E	335	6	6
F	161	4	6

Financial position.—The following table shows the financial position of the different families during the year i. e. from 1st June 1939 to 31st May 1940.

Family	Income			Expenditure			Surplus or Deficit		
	Rs.	as.	ps.	Rs.	as.	ps.	Rs.	as.	ps.
A	351	6	0	347	9	3	+ 3	12	9
B	358	11	7	351	2	9	+ 7	8	10
C	479	11	5	363	4	9	+ 116	6	8
D	171	1	0	166	13	0	+ 4	4	0
E	303	11	9	335	6	6	− 31	10	9
F	133	1	9	161	4	6	− 28	2	9

It will be evident from the above table that family 'C' alone is in a position to make Rs. 116/6/8 gain in the year. Families A, B, and D have just balanced their budget and have got nominal surplus of

Rs. 3/12/9, Rs. 7/8/10 and Rs. 4/4/- respectively. Families E and F are recording deficit of Rs. 31/10/9 and Rs. 28/2/9 respectively. This deficit is adjusted by incurring debts. The higher income in family 'C' is due to high agricultural income and the small size of the family composed of six members (equivalent to 4.2 adult male units) and efficient management by the cultivator himself.

Conclusions and suggestions.—It is now clear from a study of the income and expenditure of the cultivators that the income of the cultivators can be increased.

The following suggestions may go a long way to do that:—

(1) **Supplementing agricultural income by cattle income.**—Every cultivator should have milch cattle specially buffaloes to add to his income, as can be seen in the case of families F and C. The family C has got more income from cattle but family 'F' has not got it as it has no cattle, so family 'C' is in a better position than family 'F'. A cultivator should not have only cows, but he must have buffaloes, as buffaloes add to the income due to higher milking capacity in this locality. It can be clearly seen in the case of families C and B. B has 5 cows but it has not enough income as C has, though it has got a number of cows.

(2) **Possessing own land.**—Every cultivator should have his own land to cultivate. He should not take land on lease or ' Batai ' as a considerable portion of the income from such lands goes to the land owner and the actual tiller of the soil gets very little saving for himself. It is clearly seen from families 'F' and 'C'. Family 'F' has no land of its own, so, its agricultural income is only Rs. 51/10/9 per pair of bullocks but as family C has enough land of its own, it has more income from land i. e. Rs. 215/-/1 per pair of bullocks.

(3) **Hand-spinning and weaving.**—As has been seen, the cultivator spends about 18.06% of the total expense on clothing. He can save something from this if he spins and weaves the cloth that is required by him during his spare time. He is often free during winter and rainy season. The farmer should utilize this time in this work.

(4) **Size of the family corresponding to the size of land.**—With the increase in the size of the family the area cultivated should also increase in order to provide work to every member. It is not found in the village, as can be seen from the family 'E' which has 9 members but has only one pair of bullocks for cultivation. Due to this the family is not in a good financial condition. On the other hand family D has got only 3 members and has only one pair of bullocks, and the financial condition of this family is better.

(5) **To improve agriculture.**—Last but not the least in importance is to increase the income of the family by improving agriculture and also adopting some suitable cropping scheme which will pay more. It is clear from the case of family C which has got the highest agricultural income. This cultivator followed a judicious cropping scheme and had seed of his own for which other cultivators had to pay 'Bijhai' or 'Badi' (interest). Agricultural income should be increased by adopting better methods of cultivation, proper manuring, rotation and good seed etc.

Acknowledgment

I am very thankful to E. A. H. Churchill, Esq. B. Sc. I.A.S., Principal, College of Agriculture, Nagpur and D. P. Parsai, Esq. B. Ag., Assistant to the Oilseeds Specialist, C. P. and Berar for their guidance in this work.

SOIL CONSERVATION; SOIL EROSION AND SOME MEASURES FOR ITS CONTROL

BY MR. M. N. PAITHANKAR

Senior I. Sc. (Agr.,) Class

Introduction.—The question of soil erosion is truely a national one and must play a great part in the development of the country. In order to appreciate the vital importance of reducing soil erosion to a minimum throughout India, it is necessary to accept the fact that India is essenitally an agricultural country as opposed to an industrial one, and is almost entirely dependent on agricultural production for her economic exsistence.

It has been said that "The skin of animal is not more important to its well-being than is the vegetative cover of the earth essential to the proper condition of the soil." Due to the improper management of land and lack of care, fertile and populous lands have been turned into desolate deserts. There is ground for belief that all the great deserts and waste lands of the earth once supported enormous populations. All the deserts show the remains of cities, temples and other evidence of vast cultures and civilization.

The term "Soil Erosion" means "the loosening and removal of soil from its previous resting place through any agency and the first soil to be removed by the forces of erosion is the surface soil in which crops are rooted and from which they obtained the bulk of their food requirements."

Causes of erosion.—The rate of erosion is dependent on several factors some of which are natural and therefore largely uncontrollable, while others are artificial and therefore controllable. However it is not possible to draw a clear distinction between these two types and it may be said that one farm which has natural disadvantages may be maintained in good heart by intelligent farming practice, while another which is well favoured may be ruined by mistaken methods.

(a) Natural Factors :—(1) Intensity of rainfall, (2) Topography of land, (3) Character of soil itself.

(b) Artificial factors :—(4) Methods of working the soil, (5) Crop and rotation, (6)Humus content, (7) Selection and size of land.

(1) **Intensity of rainfall.**—It is natural that the intensity of rainfall will affect the erosion of soil. Due to the direct beating of individual rain drops on exposed areas of the surface soil much erosion takes place. Every increase in the amount and the intensity of rain causes a larger increase in the amount of run off. An increased amount of run off means an increased velocity which leads to more erosion of land. Rainfall intensity is beyond human control, but these facts illustrate the necessity not only of protecting cultivated land but also of making protective works to withstand the severe conditions.

(2) **Topography of land.**—It is a matter of observation that the land which is more steep is subjected to greater erosion than that having a gentle slope. The contour of land is also of great importance, since a steep land containing more depressions will erode more rapidly than one of even slope.

(3) **Character of soil.**—This factor deals with the chemical composition, texture and permeability of the soil. Soils varying in their chemical composition will greatly vary in their resistance to erosion. To a large extent this is due to the differences in permeability. A stiff clay soil quickly becomes water-logged and the rain water being unable to penetrate erodes the soil. The land having impervious sub-soil is also subjected to erosion due to the above reason. The actual erodibility of a soil depends upon hidden characterestics which can only be gauged by physical and chemical analyses of soil.

(4) **Methods of working.**—The soil should be kept in the best condition for encouraging the rain to penetrate where it falls. Every drop of water absorbed decreases the amount of erosion. Deep ploughing is also beneficial as it provides greater depth of loose and therefore absorptive soil. The ploughing should be done across the slope and planting on the contour, so that every crop line acts as a miniature contour ridge and thus gives the rain a chance to soak in.

(5) **Crop and rotation.**—Erosion is more in the fields where the plants are widely spaced leaving bare ground between the two rows. Also loss of water is greater with crop of this sort than with a close growing crop.

(6) **Humus content of the soil.**—It is a well known fact that humus has got the absorptive property which may be made use of in the checking of erosion. When humus and fibre are lacking in the soil, it suffers greatly from erosion.

(7) **Selection and size of land.**—Soil from lands that are situated in valleys or on the steeper slopes of hills suffer greatly from erosion. Steep lands should be avoided. Erosion is so rapid on steep slope that these lands are very quickly ruined and are expensive and difficult to protect. Steep hill sides are uneconomical for cultivation because the cost of working and protection is far too high in proportion to the yield of the crops.

A further point in connection with the size of the land is that lands in very large blocks will suffer from erosion even if almost flat, merely because of the excessive volume of the water collected on them.

Types of erosion.—There are two types of erosion :—

(a) Normal erosion, (b) Induced erosion.

(*a*) Normal erosion or geologic erosion is an intensive part of soil formation; it is an extremely slow process which nature, when left to herself, regulates and retards.

(*b*) Induced erosion however, is erosion of accelerated type which is a necessary accompaniment of man's disturbance of the balance of nature. It is the induced erosion with which we are greatly concerned.

Induced erosion is of two types :—

(i) Sheet erosion, (ii) Gully erosion.

(i) **Sheet erosion.**—The gradual removal of a thin layer of surface soil from a wide area is one of the main forms of erosion to which land cultivated in annual or seasonal crops is subject. It is a form of erosion which is caused by surface run-off water. When the intensity of rainfall is not high water accumulates all over the surface in the form of a thin sheet and also flows likewise to the low lying areas.

(ii) **Gully erosion.**—Gullies are formed by the concentrated flow of water at a velocity sufficient to overcome the resistance of the vegetation and the cohesion of the soil. Gullies are mainly formed due to removal of vegetation. On cultivated land they may occur due to the ploughing of a natural channel or ploughing down the slope.

Gully is often the only outlet for storm water and the longer their treatment is postponed the more expensive and difficult it is to control. They are generally formed by water moving at high velocity. High velocities are partly due to excessive volumes of water. Hence gully erosion may be checked by means tending to prevent excessive run off.

Control of soil erosion.—The following are the different methods for the effective prevention and control of soil erosion.

(A) **Making the soil absorptive.**—The amount of humus and soil moved is often considerable and is increased by the steepness of the slope and by insufficient checks to the movements of this water. The greater part of the soil erosion is during the first hour.

The most efficacious preventives of this form of erosion are an extremely absorptive soil, numerous spongy pits or trenches and a low growing ground cover. One of the cheapest and most effective methods of preventing sheet erosion on sloping land is to establish permanent hedges of some close growing perennial plants. The hedges should be planted along the contour lines at such vertical intervals as would best suit the slopes and the soils concerned. In this way forces of erosion will be directed along anti-erosion lines which automatically terrace the land, reducing the slope, conserving its soil and thus raising the fertility of the soil.

(B) **Strip cropping.**—The object of strip cropping is to check the rush of surface water, filter out the silt which it carries and to increase the absorption of water. The crops sown should be thick and low growing. The field may be laid out in long narrow strips across the incline and the field crop may be alternated with grasses. Grass land will check this erosion.

(C) **Ploughing or tilling across the slope.**—Ploughing should always be done on the contours with a reversible plough. A far more serious problem is the gradual conversion of ridges into level terraces by the exclusive use of reversible ploughs throwing downwards which denude the upper part of the land and piles the soil against the ridges.

(D) **Terracing the land.**—The method is widely adopted in all the countries. It is an effective method for checking sheet erosion but it is much expensive. Terracing means, dividing the slopy land into several fields by throwing bunds across the slope. All the fields get levelled and give the form of a terrace. The following method is far better and less costly as compared with this one.

(E) **Contour drains and ridges.**—Contour drains with ridges are less expensive and are most effective. Contour ridges are long, low mounts of embankments of earth running on the contour across the slope of the land. They divide the run off into small controllable volumes of water, collect the silt behind the ridges and initiate the gradual formation of platform terraces. The soil for forming contour ridges is obtained from the cutting of the contour drains on the upper side of which the ridges are constructed.

The ideal method for working out this would be to set contour ridges at such distances apart, that the toe of the one ridge is at the same level as the top of the ridge next below it.

By constructing contour ridges, the land is divided into long narrow strips and the total amount of storm water is therefore divided into small volumes which are more easily controlled. When land has been ridged, it becomes compulsory to plough on the contour ; and it is in this direct way that the most important object of ridging is achieved. The spacing of ridges should not exceed 70 yards.

Impervious soils or soils which may be sandy at the surface but have an impervious subsoil require ridges at closer spacing than absorptive soils, for the reason that they produce heavy run off.

(F) **Ploughing in the gullies.**—When the gullies are very small in the beginning they may be filled in by soil by ploughing inwards. Staking is more effective. In staking, the banks of the gullies are protected from erosion by bamboo or wooden poles. The interweaving of these stakes is done by grasses and stones.

(G) **Check dams.**—These are constructed on steeper slopes. These may be of all sizes and types ranging from small temporary constructions of stakes, to large permanent earth dams and concrete weirs.

The gullies may be covered with resistant vegetation encouraging the growth of suitable grasses. This will not only resist erosion but also reduce velocity.

(H) **Under-drainage.**— If the fields are drained by tile drains it will improve the percolation of water and thus reduce the surface run off.

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ARTIFICIAL INSEMINATION

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Preliminary work.—Mixed-farming plays an important role in the agriculture of present days. This has contributed greatly to the development of the animal breeding technique known as Artificial Insemination. This was first originated in Russia.

Work in Palestine.—In earlier times the Arabs have applied this type of breeding to their horses, while the Jewish settlers developed the same method on modern lines with a view to applying it as a routine practice in breeding dairy cattle and perhaps in all classes of stock.

In 1932, Dr. M. Sturman tried this method with cows. He inseminated, three cows which were affected with contagious abortion, with sperm collected by "Sponge" method; and only one cow became pregnant. He did not try further due to his inexperience and lack of proper instruments.

In August 1934, Dr. H. Fox took trials on cattle, sheep and goat at the Government Stock Farm, Acre. 25 animals were inseminated, 14 of which became pregnant and 19 healthy young ones were born. Then he inseminated 12 cows more, which were till then unsuccessfully treated for chronic sterility; in this case, 6 conceived and normal calves were born.

In 1935, six healthy cows were inseminated and three of these conceived. So far artificial insemination was an experiment but this gave a chance to prove its genuine value.

In the autumn of 1935, there was a serious out-break of infectious vaginitis among dairy cows in Arin Harod area. The valuable stud-bulls contracted balanitis, hence breeding had to be stopped. Therefore the stock owners were likely to suffer owing to the absence of pregnancy. An examination of infected cows revealed that the internal organs were normal in most cases; therefore, in spite of inflamed condition of the vagina there was every possibility of pregnancy if insemination could be effected. So 10 of the infected cows were served by a bull and 8 of these became pregnant after the first service only, but the bull contracted balanitis and became unfit for further use. There was a great desire to have the dairy stock of a desirable standard. And as this was not possible with local bulls, there came a necessity to find a method by which pure breed bulls could be used without any danger of infection.

So, Dr. Fox started work in the beginning of 1936 on artificial insemination. He collected the sperm in the artificial vagina of "Cambridge" pattern and it was found purer and more concentrated than that collected by sponge method. With this sperm he inseminated 52 cows and 83% healthy cows and 50% infected cows were conceived; 7 heifers which were given single insemination each were all conceived. Thus this method proved to be effective in combating sterility and also in checking the disease of infectious vaginitis. In course of time as skill improved it was observed that artificial insemination gave better results than the natural service. So far the sperm was undiluted; it was 1 cc. in quantity for one insemination of an animal. So this gives a scope that if the sperm is diluted a larger number of animals could be inseminated within the same quantity of sperm.

Thus artificial insemination offers many advantages when considered from different points of view. In the main they are :—

(1) **From Veterinary point of view.**—There is a probability of inseminating even the cows suffering from diseases of external sexual organs. (Vaginitis) and from anatomical defects of these organs (Stricture of the uterus). The general infections e. g. contagious abortion, which sometimes is a result of natural service are avoided by artificial insemination.

(2) **From breeder's point of view.**—Considerable economy of spermatozoa is made possible because semen is deposited directly into the cervix of the uterus. Potent sperm can be transported to distant places.

A great extension in the service of a valuable bull and a greater chance of males. If micro-insemination (Injection with sperm diluted) is practised there is an increase in the number of young ones which may be sired in the life time of a single outstanding bull.

(3) **From economic point of view.**—Reduction in number of sires, 81 ejaculations from one bull during a year will be sufficient to inseminate 192 calves, and even this quantity is far in excess of requirement.

It can be safely assumed that 250 cows can be inseminated with undiluted sperm from one bull in the course of one year, where only 50 cows can be covered by natural service. Thus the cost of breeding per calf will be reduced from £ 1 to 4, Sh. in addition to a small charge for the service of the skilled operator.

If sperm diluting is practised the number of calves sired from one bull in one year may be increased hundredfold.

In 1940, artificial insemination was tried at Bangalore Government Dairy and it proved a good success and twin calves were born. We hope that India may also develop this technique and thus improve the cattle of the country which are the main power for agricultural operations.

CULTIVATION OF BERSEEM OR CLOVER (TRIFOLIUM ALEXANDRIUM) AND ITS COST OF CULTIVATION ON THE COLLEGE FARM

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Introduction.—Berseem was introduced in India from Egypt about the year 1904 and is now cultivated in many provinces of India.

Varieties.—The word berseem is derived from an Arabic word Berseem which means ever green fodder. Under its name are included the various kinds of clovers grown in Egypt. There are four chief varieties of berseem viz Fahl, Saidi, Miscawi and Khadrawi; of the four varieties the last two are important. Even out of these two, Miscawi is the most important variety and is grown on a large scale, because it is tall, luxuriant in growth and consequently yields a large amount of green fodder. Berseem is grown under irrigation as it requires plenty of water during its growing period and gives four to six cuttings. The Khadrawi variety gives more cuttings than the other varieties during the same period of growth.

Advantages.—The growing of this crop on a farm is very advantageous from an agricultural point of view for the following reasons:—

(i) It gives high yield of nutritious and succulent fodder for all the live-stock kept on the farm.

(ii) It tends to prevent the dimunition of humus in the soil; as the roots of the berseem go deep in all directions and these roots and a few stems are left in the ground after the crop is harvested.

(iii) It is very useful in opening up the heavy soil, as its roots spread in all directions.

(iv) It possesses a high manurial value, as it belongs to the leguminous family. The plants belonging to this natural order have been found to possess the power of fixing the free nitrogen of the atmosphere through the action of the bacteria which live on the roots of the plants, the presence of which is indicated by the nodules on their roots. The roots of berseem have been found to contain about 5.5 pounds of nitrogen per acre.

(v) It supplies in large quantities an excellent nutritive cheap green fodder at the time of the year when such fodders are generally scarce and if at all available, the green fodder is very expensive.

(vi) Berseem can be grown very successfully in the same soil year after year without deteriorating the soil of the field.

(vii) Berseem when grown on the farm as a fodder crop, has been found to be the most valuable rabi fodder crop for dairy cattle from out of those which are grown during cold weather, as it provides green fodder continuously from December to April or May. All types of farm live-stock relish this nutritious green feed and prefer it to all other green fodders available at that time. When it is fed to milch cattle, the effect of berseem in increasing the milk flow and the butter content in the milk, is found to be marvellous. It also improves their general condition. The young calves reared on the milk of the berseem-fed cows grow strong and healthy.

(viii) Besides the above advantages, the quantity of concentrates to be given to milch or work cattle can be reduced by one third during the period the green berseem fodder is fed, without any adverse effect on the milk yield and on the general health of the herd. Berseem cultivation is cheap and it reduces the bill of expenses by one fourth.

Factors limiting the growth of berseem.—One of the chief factors which limit its production is the want of an ample and continuous supply of cheap water during its growing period from October to the end of April. The second important factor for limiting the cultivation of berseem is the want of sufficient humus in the soil. The second factor is met by adding organic manures in heavy doses at the rate of 30 cart loads F. Y. M. per acre. The quantity of water required to raise a seven months berseem crop from October to end of April is on an average, estimated to be 60 inches. Owing to these factors, its cultivation is expensive and comes to about Rs. 80/- per acre; but this high cost of cultivation in raising the berseem crop should not come in the way of its cultivation when one is particularly interested in running a dairy, which requires a large amount of nutritious and succulent cheap fodder during the whole of the year in order to keep up a regular supply of milk.

Rotation.—In Egypt whence berseem was originally imported to India, it is largely grown as a rotation crop under irrigation after cereals and cotton to restore the fertility of the soil by growing it in one-third of the whole cultivated area each year. It is due to berseem cultilvation in that country that such high yields (232 pounds of lint) of superior quality (2½ inch staple extra superfine) cotton was obtained annually. Under irrigation works and tanks, the cultivation of berseem in a regular three course rotation of rabi crops enables the land to stand the continuous cropping. It does also well as a second crop on rice lands. Besides this, it supplies sufficient green fodder to the live-stock kept on their farms when only rice or wheat is grown and its bye product, stem which is less nutritious is fed to work cattle.

Season and climate.—The plant likes warm weather and is killed both by intensive heat above 100° F and excessive cold below 32° F. It thrives well in cold weather and early part of hot weather. Excessive cold and hot drying winds retard its growth. It is found doing well as a rabi crop between temperatures of 40° F to 90° F.

Soil.—It does well on deep loamy (well drained) soils containing humus in sufficient quantities and also in most other soils, provided they are in good condition and retain moisture. The crop does not flourish in water-logged soils and hence the drainage of the soil where berseem is to be raised, must be satisfactory. Few crops seem capable of adapting themselves to such a wide range of soils as berseem.

Manures and Fertilizers.—Berseem does not grow well unless the field has been previously well manured. In poor soils it fails miserably in the first year, but improves both in yield and quality in the following years. Well rotten and well made farm-yard manure at the rate of 12—15 tons per acre or any other organic manure is to be put in August and ploughed in deep. It is found economical to add soluble superphosphate at the rate of 500 pounds per acre early in October and mixed with the soil by bakhering the field twice. The addition of superphosphate increases the outturn per acre because all the leguminous crops need phosphates (P_2O_5) in large quantities.

Irrigation.—The cultivation of berseem crop should not be taken in hand unless there is an ample supply of water during its growing period from October to May. The crop is irrigated four times during its early growth and then at intervals of eight to ten days depending on the climatic condition of the place. The first three irrigations are light, about an inch deep. When the crop is more than 6″ in height, the quantity of water applied is between 2 to 3 acre inch deep. The total quantity of water required to raise the crop from the time of growing in October to the end of April or beginning of May is far in excess of that required by any other crop grown in the rabi season in the province. The crop is irrigated according to certain definite routine which is decided by the experience of the grower, as the quantity of water to be applied depends on the kind of soil and the climate of the place where it is grown. As a general rule, the maximum quantity of water applied in each irrigation should not exceed two inches at an interval of every seven days and provision for this should be made before hand. The actual requirement of water for raising 87,000 pounds of green berseem crop containing 80% water in this province would be 60 acre inches.

The irrigations are given in the manner described below. The first irrigation being one inch deep is given just after sowing the seed. The second light irrigation of about ½ an inch is given very gently after three days when the seed has just begun to show signs of germination. Care should be taken at this time of irrigating the crop, otherwise the seeds about to germinate will be damaged. The third irrigation of about one acre inch is given just four days after the second irrigation. The fourth irrigation about 1½ acre inch is given 5 days after the 3rd irrigation and the fifth seven days after the fourth. After this the crop is irrigated once in every 10 days regularly till the crop is ready for harvesting. Under Nagpur conditions after 13 days growth of the crop three irrigations are given for each cutting. One irrigation is given just after cutting, the second

10 days after cutting and the third 20 days after. The crop is harvested at the end of 30 days from the previous cutting. Thus the total number of irrigations required to raise a good crop of berseem is (5+3× number of cuttings=5+3×5=5+15)=20.

Method of cultivation.—The seed is very small nearly 60,000 weighing a pound and the young seedlings are also very delicate to start with. Hence it is quite essential that a good tilth should be produced before the seed is sown. After the removal of the preceeding crop, well rotten manure at the rate of 15 tons per acre is evenly spread and then the land is immediately ploughed about 8″ deep with the soil-inverting plough during the end of August or early part of September. The land is exposed for a month or so. The fine seed bed is got by repeated bakherings, when it is in good working condition. Before sowing, all the weeds and stubbles of the previous crops are removed, as they check the growth of the crop in its early stages.

Layout.—The plots to be sown with berseem seed must be dead level because the young seedlings die out in stagnant water. The size of the beds depends upon the nature of the land and also upon the system of irrigation practised. The chief point to be kept in mind in the cultivation of berseem is that it requires an extensively large amount of water to yield the heavy crop of green fodder that it is capable of producing. The fields in which it is proposed to grow the crop, may thus be suitably laid out for convenience of irrigation. Experience on the Nagpur Farm has shown, that when much levelling is to be done to get the fields in dead level, a plot measuring 21'x21' is a very suitable unit and is also very convenient for economical irrigation. The general layout should not be attempted without a careful survey having been made of the nature of the soil before hand. There should be an ample cheap water supply delivered at the highest point in the area with irrigation channels so arranged as to run along the highest parts of the plots to be irrigated. Each bed should be irrigated direct from the distributory channel.

Seasons.—In India the sowings are done from September to December depending upon the temperature of the atmosphere which should not be more than 100°F, so much so the time of sowing differs in different provinces and also in the different tracts of the same province. The germination of seed has been found very successful and satisfactory when the maximum temperature during the sowing period was between 90° and 95°F, and hence the best time for sowing berseem has been determined, by long experience, as the middle of October or the time at which, wheat is sown, though good results have also been obtained by sowing early in

October in some years. But in general and in the majority of cases the second fortnight of October has given the best results. The sowing of this crop may be done at any time during the months of November and December, but sowing beyond the last week of October, will be less economical to grow such a costly crop as berseem. Besides this, the late sown fields may receive a severe check from cold weather during the months of December when the berseem crop sown late will be young. The earlier the crop is sown, the larger the number of cuttings obtained. If continuous supply of green fodder is desired, sowings are done at an interval of 10—15 days depending upon the quantity of fodder required per day. The different sowings are to be done during the second fortnight of October and November. The success of early sowings is due to rapid establishment of the root system of the crop at this time of the year when the nitrification in the soil is in full swing. Frosty weather and low temperature below 38°F and above 32°F even temporarily retards growth even in established fields of berseem whereas the growth of the growing plants practically comes to a standstill in a very young stage. The crop of berseem dies in hot weather when the maximum temperature of the atmosphere rises above 105°F.

Methods of sowing.—(1) The normal method of sowing berseem and which has been taken from Egypt is identical with the *Lahi* system of sowing paddy in the province, in which the seeds of paddy which have been brought to the point of germination by being soaked in warm water for twenty four hours, are sown in soft mud of the rice plots. The day before the berseem crop is to be sown, the seed is put in water and allowed to soak overnight. On the next day the field is watered heavily (about 6—8 inches deep) and ploughed and cross ploughed, levelled and finally smoothed with tined harrow. If there is more than 2 inches depth of water standing in the plot the excess water is drained off. The germinated seeds are broadcast evenly on the surface at the rate of 40 pounds per acre. These seeds sink to the bottom and on the disappearance of the standing water, they germinate quickly. This particular method is only useful in light soils which do not crack but it is not suitable for the loamy or any other soils which crack badly. (2) When the berseem seed is to be sown in the rice plots where the crop is standing, it is broadcasted at the rate of 50 pounds per acre in the standing crop of paddy just after the last irrigation is given to the paddy crop. The young seedlings which come up in two days' time after sowing, are protected from the hot sun and winds. This method requires more seed, as some will be on the surface of the plots and are lost, but it is a cheap method of raising berseem and by this method the berseem seed can be sown one month earlier than when sown by the other methods. (3) The more common method followed for sowing berseem seed is the sowing of seed in the dry soil when it is broadcast evely in the already prepared seed bed at the rate of 40 pounds per acre. The seed thus sown is mixed thoroughly with the soil by means of a rake. Light and slow irrigation is then given carefully so that the seeds may not be washed away.

Seed rate.—Hitherto the great drawback to the cultivation of berseem in India has been the difficulty and expense of obtaining seed from Egypt, but now this difficulty is overcome by the production of the seed in different parts of India. Inspite of its production in India, the item of cost of seed in its cultivation is very expensive, being Rs. 15/- to 20/- per maund. As the seed is a very expensive item it is very important and necessary to keep the seed rate as low as possible, but in new land that has not previously grown the crop, the economy of sowing seed should not be pushed too far. In such cases the seed rate of 60 pounds per acre is adopted. In the following year, the seed rate per acre may be reduced to normal. In general, the seed rate on well manured sweet soil of loamy nature or sandy soils is 30 pounds per acre, while a higher seed rate of 40 pounds is given to heavy soils. Each plant requires 4 square inch area for its healthy growth, so the quantity of seed required per acre is $\frac{43{,}560 \times 36}{60{,}000} = 26$ pounds per acre or say 30 pounds. A good light irrigation should be given just after sowing the seed in order to secure satisfactory germination. The seed germinates within thirty hours under favourable condition of soil and climate and when there is sufficient moisture in the soil. Sometimes the germination is defective and extra seed should be sown a second time immediately. It is of great importance to see that the germination is even on the whole of the area and each plant of berseem is growing in 4 square inch area. If the young seedlings are thicker or thinner than this, the outturn of the crop is reduced, as the thick crop has not sufficient space for tillering and later growth, while the thin crop has got more space than necessary.

Top dressing.—Berseem is a crop that adds very large quantities of nitrogen to the soil, but this is not sufficient to produce the bumper crop of 40 tons per acre, so it is better that a light dressing of nitrogen fertilizer, supplying twenty pounds readily available nitrogen per acre in the shape of 100 pounds of ammonium sulphate, is applied with advantage. During its early growing period, the small amount of available nitrogen helps it to tide over the starvation period between the time when the actual seed itself ceases to supply nitrogen and the time when the nodules actively develop. Besides this the yield of berseem crop is so large that the bacteria on the roots cannot meet with the demand of the growing crop, hence it is advisable if possible to supplement the quantity of nitrogen of the air by the application of ammonium sulphate at the rate of 100 pounds per acre after each cutting.

After care.—Berseem crop, in general, does not require any after care or treatment except proper irrigation. If the growing crop is well attended to, there is a greater possibility of getting a larger number of cuttings during its growing period.

Time of cutting.—Under proper conditions of care and irrigation, the first cutting of the crop is got in 6 to 7 weeks after sowing and subsequent cuttings at intervals of a month thereafter. At the time of cutting the soil must neither be too hard nor too soft.

Growth at the time of cutting.—The first cutting of the crop is taken when the plants are about 9 or 10 inches high, at a time when a few flowers are seen in the growing crop as are generally noticed in the fields. An early cutting will induce strong growth and a uniform crop for subsequent cuttings. Berseem yields the highest outturn of green succulent fodder per acre during the second and third cuttings. When grown for the first time in the uninoculated field, the berseem crop is slow in becoming ready for first cutting but when the crop is cut down when it is about 9″ high its growth subsequently is vigorous and becomes ready for the next harvesting in 5 weeks time and gives high yields.

Seed production.—No definite attempt has been made to produce seed on a large scale in the province, except on the Military Dairy farm at Jubbulpore, since it is not economical. The seed can be produced at the sacrifice of a large amount of green fodder which has a high value at a time when no green food for the farm live-stock is available so cheap. Trials of seed production were made on Government farms and it was observed that the berseem crop for seed production would have to be left uncut after the third cutting, that is to say, the fourth, fifth and sixth cuttings are sacrificed. The value of this green fodder weighing about 40,000 pounds at the market rate of 250 pounds per rupee ~~acre~~ will not be less than 160/- per acre. Under ordinary conditions only 200 pounds of seed per acre from berseem crop is obtained and this can be had for less than Rs. 50/- from the North-West Frontier province. Besides this, there is also a good deal of trouble in threshing and cleaning the seed. Seed production can only be worth while where green fodder has a very low value, as in the case of tracts under irrigation works, where it is grown in abundance far in excess of the demand for it. Hence it is economical to get seed from other places in as large quantities as may be required.

Symptoms of poor crop.—It has been observed invariably in all places where berseem is grown for the first time that the plants of berseem do not make a vigorous growth. The scanty yellowish green foliage often becomes red. By uprooting the plants from the ground, it is marked that these plants do not bear nodules on their roots and their tillering qualities are very poor when compared with those plants of healthy growth which have nodules on their roots.

Causes of failure.—Nitrogen is one of the most essential constituents of food for all plants and the soil is a medium for its supply from various sources. In case, sufficient nitrogen is not available in the soil, the plants remain stunted and unhealthy. Leguminous crops contain more nitrogen than any other farm crops, and therefore, they require more of this element in the combined form in the soil for their normal growth. In the presence and through the agency of the proper kind of bacteria which are of particular kind for particular leguminous plants, such plants can draw their nitrogen supply from the atmosphere, even if the soil in which they grow, happens to be poor. In the absence of proper bacteria and of available nitrogen in the soil, the legumes do not grow well. This is exactly the case with berseem crop. Indian soils, in general, are admittedly low in organic nitrogen content and the specific bacteria are not present in most of them as that particular crop was never grown on this soil. These causes account for the failure of berseem crop.

Remedy.—An artifical inoculation of soil or seed with proper strain of bacteria which can be had in the market, will be found very useful for this purpose. The most economical method of inoculation is to spread in the evening, on the field, surface soil (top 4″) from a field where berseem has been growing for the last five years, at the rate of 500 lbs. per acre and mixing the same thoroughly with the soil by bakhering and cross bakhering. It has been noticed that the yields of green fodder grown from the inoculated berseem seed or soil where much higher than those from the uninoculated seed or soil.

Feeding value.—Green berseem fodder is most suitable as a food for dairy cows and buffaloes, but it is also fed to horses, mules, work cattle etc. If it is fed in large quantities to animals it is apt to cause swelling particularly when fodder is scarce and animals over eat. This is because berseem being a very rich fodder causes acute indigestion by over eating, until the animals become accustomed to it. In some cases the over eating may even prove fatal, unless the necessary treatment is expeditiously given. By way of precautionary methods, the animals should be made accustomed to increase the quantity gradually when it is being fed in the stall. Five pounds per head per day are ample to begin with and it may be steadily increased to ~~£.60/-~~ per day if available. When green berseem is fed to animals, not more than 40 pounds should be given at one feed and not more than one tenth of the live weight of the farm live-stock per day regulated into two or three feeds. Drinking water should not be given to the animals immediately after feeding the berseem. At least an interval of half an hour should be allowed.

Analysis of green berseem and clover hay are as follows:—

		Green berseem	*Clover hay*
Moisture	...	81.63%	6.01%
Oil	...	0.51%	2.63%
Proteins	...	3.22%	12.14%
Carbohydrates	...	8.26%	46.24%
Fibre	...	4.00%	22.03%
Ash	...	2.38%	10.95%
Sand in ash	...	0.15%	1.44%
Food units	...	18	83

Yields.—In order to get the largest possible outturn there should be no delay in cutting; if left too long, the stem hardens and the stock do not relish it. The crop also lodges. In cutting the crop, the stems should be cut close to the ground with a sharp sickle in order to reduce tillering in subsequent cuttings. With early sown berseem about the middle of October, six cuttings, each at an interval of 4 weeks, are obtained. The total yield from these cuttings varies from 60,000 to 87,000 pounds per acre depending upon the quantity of manure applied, timely irrigation and the time of cutting the crop. This yield surpasses all other green fodders in point of outturn in the rabi season.

Disposal of produce.—Berseem is mainly a green fodder. A good hay can however, be made, but it is difficult to handle it as it becomes brittle. Other uses are green manuring, silage making and the production of seed.

(1) Hay making :—Under ordinary conditions hay making does not pay because it must be recognized that berseem is a very watery plant and only 15 to 20% of the green weight of the berseem is obtained when made into hay. A higher percentage of hay is obtained later in the season, when growth has become slow and the plants are less succulent. The last two cuttings are most suited for hay making, but that is the time

when green fodder is not available at all. For hay making the green berseem should be cut and allowed to partially dry in the field for three days, and during this time it should be turned twice or thrice. It should then be spread in three layers and turned every alternate day until the material is dry but not so dry as to become brittle. It may then be stored on a raised platform protected from rain and sun.

(2) Berseem has proved of very little value as green manure due to its high content of water and also high cost of cultivation. Thus on an average cutting of 15,000 pounds of green fodder per acre worth Rs. 60/-, supplies only 2,250 pounds of dry matter to the soil or roughly one ton. One ton farm yard manure will not cost more than Rs. 6/-, so that on a theoretical basis farm yard manure is ten times as cheap as berseem for green manure.

Cost of cultivation of berseem on the College Farm, Nagpur.

Field No.	...	14
Area	...	2.00 acres
Soil	...	Morand
Position	...	Level
Rotation	...	Maize or groundnut continuously cropped since the year 1903 to 1940. *(now it is students garden area)*

(Maize and groundnut are sown in alternate years during rains)

Mixture	...	Nil
Irrigation	...	The plot is irrigated from the Telankhedi-Phutala pipe line.

Manure.—Maize or groundnut was manured with farm yard manure at the rate of 16 cart loads (6 tons) per acre during the early part of June every year and buried into the soil by shallow ploughing 6″ deep.

Maize was sown early in June under irrigation. It was top dressed with ammonium sulphate at 100 pounds per acre. Green cobs were sold during the middle of August.

After the removal of maize crop the field was manured with 16 cart loads (6 tons) of well rotten farm yard manure and burried with soil inverting plough 5″ deep.

Preparation of seed bed.—3 bakherings.

Charges.—Working hours—9.

Manure.—Rs. 1/8/- per cart load (1,100 pounds.)

Carting charges.— -/1/3 per cart.

Spreading charges.— -/-/9 per cart.

Ploughing.—Hire of one C. T. Plough = -/2/- per day
2 pairs of bullocks— @ -/10/- per day
3 men ... 1 man @ -/6/- per day
2 men @ -/5/- per day
0.50 acres per day.

Bakhering.—3 bakherings
One pair of bullocks @ -/10/- per day
One man ... @ -/5/- per day
1.50 acres per day
-/-/6 charges for bakher per day.

Removal of weeds.—2 women @ -/3/- per day
1.00 acres cleaning of weeds.

Making ridges and beds.—1 pair of bullocks
2 men— 1 man @ -/7/-
1 man @ -/6/-
2.00 acres per day.

Dressing the ridges and levelling the land.—10 coolies per acre per day @ -/5/- per day.

Sowing seed.—One man— -/7/- per day
2.00 acres per day.

Irrigation.—Rs. 10/- per acre

Land Revenue.—Rs. 2/8/- per acre

Cess.—One anna per rupee.

Overhead charges.—Rs. 15/- per acre for berseem per annum.

Cost of seed got from the Frontier Province—Rs. 25/- per maund of 40 seers including all charges.

Cost of ammonium sulphate @ 6/- per 100 lbs.

Spreading manure ... 1 woman @ -/3/6

Outturn—1st cutting ...	8,000	pounds per acre—	1st December
—2nd „ ...	15,000	„	— 1st January
—3rd „ ...	15,000	„	— 1st February
—4th „ ...	13,000	„	— 1st March
—5th „ ...	7,000	„	— 1st April
—6th „ ...	2,000	„	—20th April

60,000 lbs.=26 tons (nearly) per acre.

Market value=Rs. 9/- per ton.

Cost of cultivation of Berseem over 2 acres (Field No. 14)

	Bullocks	Men	Women	Rs.	as.	ps.	
Farm yard manure 32 cart loads ...				48	0	0	
Carting manure 32 cart loads ...				2	8	0	
Spreading manure—32 cart loads ...			8	1	8	0	
Ploughing ...	8	12		9	8	0	
Bakhering—3 ...	2	2		1	14	0	
Removal of weeds ...			4	0	12	0	
Making beds with plough ...	1	2		1	7	0	
Dressing the beds ...		20		6	4	0	
Cost of seed 45 pounds ...				14	1	0	
Sowing seed ...		1		0	7	0	
Raking seed ...		10		3	2	0	
Irrigation charges ...				20	0	0	
Men employed to irrigate 1st		2		0	10	0	
„ „ 2nd		2		0	10	0	
„ „ 3rd October...		2		0	10	0	
„ „ 4th		2		0	10	0	
„ „ 5th		2		0	10	0	
Ammonium sulphate 200 lbs. ...				12	0	0	
Spreading manure ...			2	0	7	0	
Irrigation—3 times (November) ...		6		1	14	0	
Harvesting 1st cutting (November end)...			18	3	6	0	16,000 lbs.
Ammonium sulphate 100 lbs. ...				6	0	0	
Spreading charges ...			2	0	7	0	
Irrigation 3 times (December) ...		6		1	14	0	
Harvesting 2nd cutting (early in Jan.) ...			23	4	5	0	30,000 lbs.
Ammonium sulphate—100 lbs. ...				6	0	0	
Spreading charges ...			2	0	7	0	
Irrigations 3 times (December) ...		6		1	14	0	
Harvesting 3rd cutting (January end) ...			23	4	5	0	30,000 lbs.
Ammonium Sulphate—100 lbs. ...				6	0	0	
Spreading charges ...			2	0	7	0	
Irrigation—3 times (January) ...		6		1	14	0	
Harvesting—4th cutting (February) ...			17	3	3	0	26,000 lbs.
Ammonium Sulphate—100 lbs. ...				6	0	0	
Spreading charges ...			2	0	7	0	
Irrigation 4 times (March) ...		8		2	8	0	
Harvesting—5th cutting (March) ...			12	2	4	0	14,000 lbs.
Irrigation 5 times (April) ...		10		3	2	0	
Harvesting 6th cutting (April) ...			5	0	15	0	4,000 lbs.
Land Revenue ...				5	0	0	
Cess etc. ...				0	5	0	
Overhead charges ...				30	0	0	
Total expenditure for 2.00 acres ...	...		...	217	9	0	=120,000 lbs.
∴ Expenditure for 1.00 acre ...	...		...	108	12	6	= 60,000 lbs.
The value of the produce=60,000 pounds=26 tons @ Rs. 9/-/- per ton ...	...		...	234	0	0	per acre.
Less cost of cultivation ...	...		...	− 108	12	6	
Net profit per-acre ...	...		...	125	3	6	

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Extract

BRIEF DESCRIPTIONS OF THE PRINCIPAL INDIAN BREEDS OF CATTLE, THEIR HOMES AND THEIR CHARACTERISTICS.

(Continued from our last issue pp. 36).

Kankrej.—This is one of the most prized breeds of cattle in India. Its home is the country to the south-east of the Rann of Kutch, extending from the south-west corner of the Tharparkar district of Sind to Ahmedabad in Bombay province and from Deesa in the east of Radhanpur State in the west, particularly along the Banas and Sarasvati rivers. In Radhanpur State it is known as the Wadhiar breed. In addition to their own areas these cattle are very extensively used in Kathiawar and Baroda States and in Surat for draught purposes.

They have long been carefully bred in herds which subsist largely on the extensive grazing which is available during a great part of the year in and around the Rann of Cutch, supplemented in the best herds by concentrates and specially grown fodder and grain crop residues. They are very highly prized as fast, powerful draught cattle and, in the past, were extensively exported to America and other countries for grading up the indigenous cattle. In this way Kankrej cattle have been largely instrumental in the formation of beef breeds in those countries which are better able to withstand tropical conditions than the indigenous stock of European origin.

Kenwariya (or Kenkatha).—This is a well-known breed of Bundelkhand and is found along the Ken river in Banda district.

The cattle of Kenwariya type are also bred in the territory of Panna, Bijaigarh, Charkhari and Ajaigarh States of Central India, in the United Provinces. This breed is very popular for light draught on the road and for cultivation.

It is a small sturdy and fairly powerful animal of a rufous colour which is well suited for the work of the tract.

Kherigarh.—This breed is generally found in Pargana Kherigarh of Kheri district.

The cattle are very active and like free grazing.

The bullocks are good for light draught and trotting purposes, but the cows are poor milkers. They are best suited for Tarai tracts.

Killari.—This is a well-known draught breed of the southern portion Bombay Province which is bred mainly in Sholapur and Satara districts.

It is a derivative of the Amritmahal but is not so compact or fine in quality or so active as the best specimens of that breed and seems to have a strain of the grey-white cattle of the north in its composition. They are very hardy cattle, able to endure scarcity of fodder, and are much appreciated for their strength and powers of endurance under the plough or on the road.

Krishna valley.—The home of these powerful cattle is the black cotton soil of the watershed of the Krishna and the rivers in the southern portions of Bombay Province and Hyderabad State. They are reared mostly by cultivators on their holdings and are to a large extent fed on specially grown fodder crops and grain crop residues.

The bullocks are very powerful animals, useful for slow draught or heavy plough in black cotton soil, and the cows are as a rule fair milkers, but the breed is not a well-fixed one and considerable variation occurs, due to more than one basic type having entered into its composition.

The colouring and general characteristics indicate that large, grey-white cattle from the north are the basis of this breed but a careful study of individual animals reveals evidence of the blood of the Mysore basic type.

Lohani.—The home of this breed is the Loralai Agency of Baluchistan and the northern districts of the North-West Frontier Province, and it is also found fairly widely distributed in the tribal areas and in Dera Ismail Khan District of the Punjab. This breed has not yet been much studied, but preliminary observations show that the Lohani has potentialities for milk production and possesses at the same time good draught qualities for hilly tracts.

The Lohani is a small animal similar to the hill cattle of India. The characteristic colour is red with white patches although an entire red colour is not uncommon.

Cows of this breed are said to yield up to 10 lb. of milk a day.

Malvi.—These cattle are found at their best in the comparatively dry Malwa tract of the Central India Agency, where large numbers of cattle are reared on natural grazing supplemented, particularly in the areas where the best cattle are bred, by the residues of grain crops and some specially grown fodder crops.

Cattle of the Malvi type are also bred in a less well-developed form in the northern portions of the Central Provinces and the north-eastern section of the Nizam's Dominions, and are a very popular breed for medium and light draught on the roads and for cultivation. They are massively built, compact animals.

There are two distinct types of Malvi cattle; the big Malvis bred in the south-west of Gwalior State and surrounding area and the small Malvi bred south-east of this area.

Mehwati (Kosi).—Mehwati (Kosi) cattle are bred in large numbers in the western portions of Alwar and Bharatpur States and are valued as powerful, docile cattle, useful for heavy plough and carting. They are similar in type to the Hariana breed but show definite evidence of a large admixture of Gir blood in their composition.

Nagore.—This is one of the most famous breeds of trotting draught cattle of India. Its home is in the North-east of Jodhpur State, where its breeding has long been carefully carried on, as a means of livelihood, by the cultivators of this comparatively dry tract. It seems probably that some of the blood of the grey cattle of the country to the south and south-west has entered into the composition of this breed, but mainly they appear to be of the type of the white cattle which appear to have entered India separately from the greyer type.

The bullocks are very big animals and are much prized as powerful trotting cattle for fast road work. They are purchased in large numbers at the annual Parbatsar fair at high prices.

Nimari.—These cattle are largely bred in the valley of the Narbada river and are much prized as active work-cattle. They are, however, not a fixed breed, being the result of cross-breeding between the Gir cattle of Rajputana and the Killaris of the area south of the Narbada.

Ongole.—The cattle of the Ongole tract of the Madras Presidency are among the best known breeds of Indian cattle and are much valued for work and for milk production. They are mostly bred by cultivators in the Guntur District of Madras and when reared on the specially grown fodder and residues of grain crops produced in this fertile tract, they are exceptionally fine animals. Ongole cattle are usually docile and the bullocks are very powerful, suitable for heavy plough or cart work but are not generally considered to be suitable for fast trotting. The cows are good milkers giving according to a recent survey, an average yield not far short of the average of more purely milch breeds of Indian cattle for which comparable data are available.

In the past, Ongole cattle were exported to tropical America and other countries on an extensive scale, many for improving the local cattle by grading, and in some of these countries herds of pure-bred Ongole cattle are now maintained to provide sires for grading up the local stock of European origin. Like all Zebur cattle, their great resistance to tick borne disease and their capacity to thrive on scanty and dry fodder, has proved of great value in building up beef breeds able to thrive under tropical conditions, and cattle with a proportion of Ongole blood are now very largely bred in such countries.

Ponwar.—This breed is generally found in Tehsil Paranpore in Pilibhit district as well as in north western part of Kheri district. The cattle of this breed are active and often furious and like free grazing. They reach maturity after five years. The bullocks are good for draught purposes. But the cows are poor milkers. They are best suited for Tarai tracts.

Rath.—These cattle are bred in the north and west of Alwar State and in the adjacent territory embracing portions of other Rajputana States to the north and west of it. Outside these areas they are also bred but are liable to be mixed with the Nagore, Hariana and Mehwati breeds. Rath cattle are medium-sized, powerful animals of fine quality and being very compact and active are suitable for medium plough or road work. The area in which cattle of this breed are seen at their best is a comparatively dry area in which crops are grown under well irrigation and the grazing is limited. Consequently the cattle are mostly maintained on cultivated land and reared and fed on grain crop residues and specially grown fodder crops, much in the same way as the best cattle of other outstanding breeds of Indian cattle are.

They are similar in basic characteristics to Hariana cattle but are smaller, well-built, deep-chested cattle, suitable for work in the plough or on the road, while the cows are good milkers. They are economical to maintain and are regarded as a poor man's breed, while Nagoris are considered to be rich men's cattle.

Red Sindhi.—The home of this breed is the country around Karachi and north-west of it, including the Las Bela area of Baluchistan where a distinct type of considerable purity is bred.

In the cattle bred in and around Karachi it is clear that there has been a large infusion of other blood, some possibly from Afghanistan, and also of the Gir, definite evidence of which can be seen in most of the best herds.

Red Sindhi cattle are among the most efficient milch cattle of India and though comparatively small the bullocks make very useful draught animals. Owing to their small size and capacity to adapt themselves to varying conditions of soil and climate, Sindhis are now extensively used for grading up local stock in other parts of India where, owing to the poor conditions under which cattle are bred and maintained, larger animals would not be suitable. Moreover, catle of this breed have been and are still extensively exported to foreign countries, such as Burma, Ceylon, Malaya States, Japan and the Phillippine Islands, and there is grave danger that, unless more care is taken to develop and preserve the bests trains in India, these countries will soon be able to meet the considerable demand for such cattle which exists for milk production in tropical countries.

Sahiwal or Montgomery.—These are essentially milch cattle which in the past were raised in large numbers in the dry central and southern area of the Punjab where, before it was brought under irrigation, there were large areas of suitable grazing in the jungle and along the banks of rivers. It is stated that large numbers of people from the south at one time came into this area, with their cattle, and there seems to be little doubt that this breed is largely derived from a mixture of strains imported from the north and south. Cattle of this breed are in fact sharply distinguished in type from the Bhangaris, Harianas, Nagores, Dhannis and other cattle of the north and west by which they are surrounded.

Owing to their milking capacity these cattle are largely exported to other areas, for milk production in cities. The bullocks are useful for slow work but the Sahiwal is not generally considered to be a good draught animal. It is reputed to be a good beef breed.

Siri.—These animals are to be found in Darjeeling, Sikkim and Bhutan. The latter country is supposed to be their real home and it is from this State that the best specimens are brought into Darjeeling district.

The colour most frequently seen in the district of Darjeeling is black and white, and red and white. The animal carries a thick coat all the year round and this offers considerable protections against the severe winter climate experienced in their habitat and the rain of the summer months.

The general form of the Siri is massive. Bullocks of this breed are eagerly sought after for cart purposes owing to their size and great strength and they will pull loads of 10 to 12 maunds over bad and moutainous roads with great ease.

The cows give, when stall-fed, up to six seers of milk daily with a butter-fat content from 5 per cent to 6 per cent. Cows under normal conditions yield from one to two seers of milk.

Tharparkar.—Tharparkar cattle are seen at their best in the arid, semi-desert tracts of south-west Sind in which they are largely bred but they are also produced over large sections of the adjoining Indian States of Cutch, Jodhpur and Jaisalmer. This area consists largely of sand dunes and receives a low rainfall. Thus, in their natural home these cattle have to subsist largely on desert grazing and bushes, supplemented in the dry season by residues of grain crops. They are a compact hardy breed.

This breed is proving to be one of the best milch breeds of India while the bullocks are good workers of medium weight useful for plough or carting. Owing to their capacity for milk production as well as work and their ability to thrive on scanty fodder, Tharparkars are now bred on a number of Government farms, away from their natural home, and are becoming very popular for the improvement of small local breeds of similar type in other parts of the country.

The cows have good milking capacity and the bullocks are good workers and desert-bred stock are particularly hardy and economical to maintain with fine bone, clean limbs, strong ankles and hard feet.

Ellichpur or Nagpur buffalo.—These are the names by which the long-horned buffaloes of central and south India are generally known. These buffaloes are of an entirely different type from the Murrah and clearly represent a very ancient indigenous type. For example, stone carvings exist in the Nizam's Dominions which show typical Ellichpur type buffaloes being used as draught animals to move the immense stone pillars which were used in the building of temples 3,000 to 4,000 years ago. Buffaloes of this type are still bred in large numbers throughout central and southern India. They are largely used for draught but are slow movers compared with good bullocks and, like all buffaloes, should not be worked during the heat of the day.

The females are considered to be fair milkers but cannot compare with the buffaloes bred in north and west India and Kathiawar. They are the principal milk producers of the Central Provinces and in the Nizam's Dominions.

Jaffarabadi buffalo.—Jaffarabadi buffaloes are very massive animals which are seen in their purest form in ths Gir forest of Kathiawar where they are bred in large numbers. particularly for ghee production. They are very large animals and require large quantities of fodder but the milk yield is high and the butter-fat content exceptionally so. A noticeable feature of the Jaffarabadi buffalo is the very prominent forehead and the heavy horns which are inclined to droop on each side of the neck and then turn up at the points but not in such a tight curl as in Murrah buffaloes.

Kundhi buffalo.—These are large animals with a live weight varying from 1,000 to 1,200 lb. inhabiting the forest tracts along the river Indus and in the rice growing regions in north Sind. The colour is usually jet black, although light brown animals are also found.

The cows are good milkers with an average yield of 10 seers per diem, but first class animals are reported to give as much as 20 seers daily.

Mehsana buffalo.—The Mehsana buffaloes of Baroda State and neighbouring areas appear to be intermediate between Surti and Murrah buffaloes but vary from taluka to taluka.

Mehsana buffaloes are considered to be particularly valuable milch cattle because of their early maturity, persistence in milk and regularity in breeding. They are of medium size and economical to feed and are largely used for milk and ghee production in Bombay province and Bombay city.

Mehsana buffaloes appear to have been derived from a mixture of Murrah and Surti blood and Murrah bulls are still commonly used to grade them up.

Murrah or Delhi Buffalo.—The Murrah buffaloes of the southern Punjab and Delhi Province are typical of a wide range of deep, massive milch buffaloes which, with small local variations, are bred in large numbers in the north of India, particularly in the Punjab and Sind, for milk and ghee production. The area in which they are mostly bred extends from the northern United Provinces through south Punjab to Sind, but Murrah buffaloes have been introduced in many other parts of India to improve the local stock.

The best breeding areas for the true Murrah are Rohtak, Karnal, Gurgaon and Delhi, but high-yielding strains are also bred in Sind and there are well-known varieties such as the Nili or Rav buffaloes which differ only slightly from the true Murrah. Murrah buffaloes are at present probably the most efficient milk and butter-fat producers among Indian cattle but are not suitable for draught. They are used for milk and ghee production in almost all large cities throughout India and in rural areas in the north and west.

Murrah buffaloes are very massive, stockily-built animals with deep, wide frames and short, massive limbs.

Ravi Buffalo.—As the name implies, these animals are found in the valley of the Ravi river, particularly in the Sandal Bar, and they are sometimes spoken of as the Sandal Bar buffalo. These are coarse animals of a very black colour, with hair.

The cows yield a fair amount of milk averaging eight to ten seers per diem. Outstanding animals may give as much as 18 to 20 seers daily.

(Indian Information, Feb. 15, 1941).

College and Hostel Notes

The principal activities of the period under report include the Janmastami and Ganesh celebrations. The Janmastami festival was inaugurated with the "Sthapana" of Lord Krishna and an address by Dr. B. P. Mishra, M.A., LL.B., D. Litt. Other programmes included a music concert by Mr. Khare, an elocution competition and a poets' gathering, which was an unprecedented success owing to the participation by the distinguished poets, Dr. Mishra, Mr. Manzur Hussain and Mr. Sakhta. The Ganesh festival commenced with an address by S. L. Pandharipande Esquire, M A., Principal, City College, Nagpur. Other items were, a musical entertainment by Mr. Patwardhan and party, and mimics by Mr. Reter.

Two dramas, one in Hindi "Bharat Ramani" and the other in Marathi "Sonyacha Kalas" were performed. In the Hindi drama the best performances were by Messrs. R. C. Jain, G. P. Mishra, R. B. Mandloi and N. R. Sohni. In the Marathi drama Messrs. S. R. Abhyanker, S. D. Deshmukh and Deshpande (a non-collegiate) played with merit their respective roles. We are thankful to Messrs M. A. Rahim, Dr. R. L. Bhaiaji, and R. N. Kayastha for their unfailing assistance in making the Hindi drama a great success, and to Messrs. B. R. Phatak Chimote, Joshi for their timely help in directing the Marathi drama.

Condolence Meeting.—A special meeting of the Staff and Students of the College was held on 21st November 1941. A resolution expressing sincere condolences and warm sympathy on the sad demise of Mr. S. B. Gokhale was passed and coveyed to the members of his family.

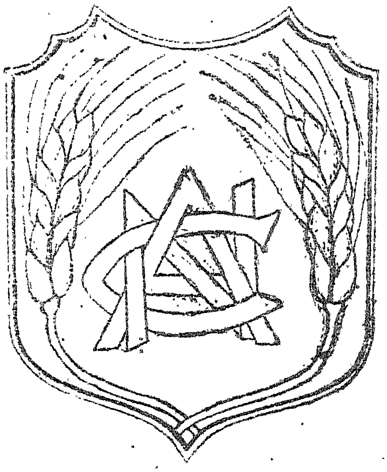
Sports.—We participated in the Nagpur University Foot-ball and Hockey tournaments of the year. In foot-ball we defeated the College of Law in the first round and lost against the College of Science in the second round. The first round of the Hockey tournament, which we played against the College of Science proved to be a very interesting contest. With luck oscillating on either side all along, we were unfortunate to have lost the match by a goal scored against us in the last few minutes of the play.

U. T. C.—Eleven new entrants to the College have joined the U. T. C. The College has done creditably well by securing a number of promotions. Corporal Ajit Singh is promoted to C. Q. M. S. and Lance Corporal D. D. Shukla becames Corporal. Messrs G. N. Raut, R. B. Mandloi and A. Q. Khan are made Lance Corporals. In the recruits competition our College stood second in the Battallion. Corporal Ajit Singh who joined the Summer Senior Cadre Course was placed in the first division. He also got a prize in the Rifle Course III part.

Hostel.—The hostel is now fully occupied and studies are in full swing. The reading-room, and the gymnasium are well provided. The Association of the Quiet Hour is holding meetings every saturday.

The Nagpur Agriculture College Magazine

VOL. XVI ⁂ NO. 3



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Editorial

NEW YEAR HONOURS

In recognition of his valuable services to the cause of Indian Agriculture, His Majesty the King Emperor of India has been pleased to appoint Mr. J. C. McDougall to be a Companion of the Most Eminent Order of the Indian Empire.

Mr. McDougall joined the Indian Agriculture Service in 1920 and has all along been working for the development of agriculture in this Province, except from 1926-28 when his services were lent to the Royal Agriculture Commission as Assistant Secretary. From 1932-35 he was Principal of this College and in 1935 was appointed Director of Agriculture of this Province. During the period 1938-40 he held charge of the Veterinary Department also.

His work on the improvement of rice and his improved system of estimating cotton outturns have been very greatly valued. Several important research schemes have been very successfully directed by him and his membership on the Advisory Board of the Imperial Council of Agricultural Research and Indian Central Cotton Committee has been of immense value.

We offer our heartiest congratulations to Mr. J. C. McDougall on the well-merited distinction conferred on him.

ANNUAL STUDENTS' GATHERING

This year, we were fortunate in having Hon'ble Mr. Brijlal Biyani,—a member of the Council of State and the President of the Berar Congress Committee,—to address us and to give away the prizes, on the occasion of the Annual Prize-giving Ceremony.

New Era.—Addressing in Hindi—the Lingua franca of India, he remarked at the outest, that in the reconstruction of the world along with the present war, three schools of thought are before us. The two i. e. Herr Hitler on one hand, and the British and the Allies on the other hand, are engaged in a war of bloodshed, based on the principles of violence. The Great Leader of India, Mahatma Gandhi, however, has his unshaken faith in Truth and Non-violence. The speaker emphasised that the true peace of the world would be established only by the means advocated by the great Indian Leader, and he further said that this should be taken as the third School of thought and a message for the world from India. Referring to the Indians, he said that each individual should contribute his or her share in the national development of the mother country. When each expected to derive benefits from the country, it was necessary that each one should also serve the country.

Duties of Students.—Drawing the attention of the students towards their duties, the speaker remarked that they should concentrate their energies in their study and in the collection of useful scientific facts. They should pay special attention to their main work of study, which will make their life successful in future. There are, however, occasions, when the students have to be one with the country in its practical politics. It is their duty to be with the country in her happy and unhappy days.

Referring to the clashes between the teachers and the taught, he said that these can be avoided by the proper co-operation of both parties. The directors and the teachers of the present institutions should encourage the development of true national and useful life among students. The students on the other hand, should have better discipline and ready obedience. They should be polite and gentle in their behaviour, and should learn to sacrifice and renounce their comforts for nobler causes.

Development of Industries in India —Regarding the development of industries, he said that India is an agricultural country and the foreigners consider this country to be a producer of raw material for their factories. This country is supposed to be a market for their finished products.

He declared that this state of affairs was quite unsatisfactory and the past history of this country revealed that there were in it well developed industries in the past. He further said that it was the duty of each Agriculture College Graduate and those connected with this College to help in the development of suitable industries in this country, so that the raw material produced in it may be fully utilized to increase the wealth of the nation. He believed that with the proper industrial development in the country, each village will become self-supporting. He emphasised on the need for work in villages and advised students to go there and work shoulder to shoulder with the farmers. He considered the village to be the place for real service and uplift work.

Original Articles

PREPARATION OF JAM, JELLY, MARMALADE, PRESERVE AND CANDIED FRUIT FROM SOME COMMON FRUITS OF THE CENTRAL PROVINCES

By Dr. V. G. Vaidya, B. Ag., Ph. D. (Bristol)

(*Assistant Professor of Agriculture, College of Agriculture, Nagpur.*)

Preservation of fruit in concentrated sugar solution is practised in India since ancient times and the art is handed down by means of recipes which were found by experience to yield fairly satisfactory results. Indian housewives make excellent preserves (*Murabbas*) from several locally grown fruits like mango, plum apple, Karwanda (*Carrissa carandas*), Amla (*Phyllanthus emblica*) etc. In addition to these, jams, jellies and marmalades are also prepared and imported into India and are gaining popularity. There is a great scope for the manufacture of these products owing to the availability of plenty of lower grade fruit at very cheap prices during the season. In this article the general principles of jelly, preserve and candied fruit making are described and several recipes which are tried and found successful are given.

What are these different products ?.—A jam is a preparation consisting of whole fruit boiled with sugar having a fairly firm consistency. Scientifically a jam consists of fruit tissues embedded in a reasonably firm pectin-sugar-acid jel.

A jelly differs from a jam in as much as it does not contain fruit tissues. The pectin is extracted from the fruit tissues by boiling with water, extract being separated from all solid material by filtering. It is then added with sugar and concentrated to such a consistency that it forms a jelly on cooling. A perfect jelly is clear, sparkling, transparent and attractive in colour. When removed from the container it should retain its form and should quiver but not flow. It should not be syrupy and sticky or gummy and when cut, it should have a sharp edge and sparkling cut surface.

A marmalade is clear jelly in which slices of peel are suspended. In principle, jam, jelly and marmalade are the same and apart from the questions of flavour and colour, their method of manufacture turns on the properties of pectin and the laws governing the formation of pectin-sugar-acid jel.

A preserve is a product made by cooking the prepared fruit in sugar syrup until the concentration reaches 65—70 percent. The fruit is not embedded in pectin-sugar-acid jel but is permeated with syrup without shrivelling it. It should retain its form and should be crisp rather than sift. Preserves are more sweet than former products and are relished by Indians. In every Indian family annual stock of preserves is made when fruits are available in plenty.

Candied fruits are prepared by gradually concentrating fruit in syrup by repeated boilings until the fruit is heavily impregnated with sugar. This process is followed by drying to overcome stickiness.

Science of jelly making—Pectin-sugar-acid jel.—The important constituents of jams, jellies and marmalades are pectin, sugar and acid. They should be in right proportion for the jelly to set.

Pectin occurs naturally in all fruits and is highest in sound ripe fruits; hence the ideal stage of gathering fruits for these products is the just ripe stage. Some fruits are richer than others in their pectin content. Citrus fruits are very rich in pectin and so pectin is manufactured on a commercial scale from the white of the rinds of citrus fruits. Pectin is contained in the cellular material of the fruit and is extracted by boiling the fruit in equal quantity of water for about half to one hour. For this purpose monel aluminium or stainless steel pans should be used. As the fruit and the peel soften, the pectin comes out with the juice and is dissolved in water.

Test for pectin.—The quantity of pectin dissolved in the juice extract is determined by carrying out an alcohol test. For this purpose a teaspoonful of juice extract is taken in a glass cup, allowed to cool and three table spoonfuls of methylated spirit are added. Shake the cup gently and the pectin will settle down at the bottom of the cup forming a jelly like clot. Pour off the water, spirit and the clot in another cup and find the consistency of the clot. If the clot separates in smaller clots the pectin is present in the juice in small quantities A little more boiling may be given to extract more pectin. If the clot is firm enough to hold into one, the extract may be considered rich in pectin. The fruit should then be strained through a flannel jelly bag fitted to a stand. The jelly bag is scalded with boiling water before the pulp is poured into it. This helps in straining the juice. The cooked pulp is tipped gently into the bag and allowed to drain until the residue is dry and until there is no more liquid dripping from it. In no case should the juice be squeezed out of the bag. Some fruits are very rich in pectin and it can be extracted for the second time also. The two extracts should then be mixed together.

Acid.—It has two functions in the preparation of jams and jellies. It assists the solution of pectin in the juice and combines with that substance and sugar to form a jel. There is a certain range of acidities in which jellies form; below this range the jel forming capacity falls off. Fruits deficient in acid, therefore, do not make good jellies. In such cases lemon juice, citric acid or tartaric acid may be added to the extent of 1 oz of lemon juice or 2 gms of citric acid to every four pounds of juice extract. Too much acid causes the jelly to ' weep.'

Sugar.—It plays an important role in jel formation. The percentage of sugar should be 10 to 65% of the weight of the jelly. When it is less the jam or jelly may ferment, whereas, if too much sugar is added there is a possibility of some sugar crystallizing out and the product is liable to be syrupy. The amount of sugar required to make a good jelly depends on the quantity of pectin and acid present in the juice. If good pectin clot is obtained, 1 lb. of sugar may be added to 1 lb. of juice extract. If the pectin clot is only fair, ¾ lb. of sugar should only be added to each lb. of juice extract. If a jelmeter is available it may be used with advantage to determine the right amount of sugar to be added.

Cooking.—The juice extract is brought to boiling and the required amount of sugar is added gradually to the boiling juice and stirred until all of it has dissolved. The extract is strained hot through a coarse cloth to remove impurities. Boiling is then continued vigorously till the following tests are obtained.

(1) **Flake test.**—When the boiling jelly forms large bubbles and tends to bump a little, a clean wooden spoon should be dipped in and taken out and turned horizontally in the hand for a few seconds to allow the jelly to cool slightly. The jelly should then be allowed to drop from the edge. If the jelly flows down in thick drops more cooking is required but if it drops in flakes which break in a clean sharp manner the jelly has reached the final stage.

(2) **Drop test.**—A drop of the boiling mixture is placed on a cold plate and allowed to cool and set. If the drop on cooling sets the jelly has reached the finishing point.

(3) **Temperature test.**—A thermometer may be used with advantage. Provided there is the right proportion of the three substances pectin, sugar and acid, a good jelly will result after boiling to 220° F.

(4) **Weight test.**—Correct stage may be obtained by means of weighing the jelly or jam at intervals. For domestic use a convenient way of doing this is the use of a spring balance. A jelly should contain 60—65% added sugar and so sugar in any recipe may be made the basis of calculation in finding out the boiling out or final weight of jam. If the weight of sugar in the recipe is multiplied by 100/60 it will give the boiling out weight. When simplified this is:—weight of sugar × 5/3= boiling out weight. e. g. if a recipe gives 6 lbs. sugar the weight to which a jam or jelly should be boiled is 6×5/3=10 lbs. To this the weight of the pan and spoon must be added. Cooking should be stopped when the required weight is recorded.

Filling.—The jelly should be filled whilst hot into clean glass jars which have been heated in an oven and allowed to cool overnight. On cooling a wax paper may be placed over the surface and lids fixed in position.

Recipes.—The following are a few recipes which have been tested and found successful with fruits grown in the Central Provinces.

Nagpur orange marmalade.—Sweet and bitter marmalades could be prepared out of Nagpur oranges, to suit different tastes. The flavour and colour of the product is so excellent and rich that it is found to be superior to imported brand in these respects. Oranges and lemons are taken in the following proportions.

(1) Medium sized winter crop oranges 8 and lemons 6

(2) Summer crop oranges 8 and lemons 8

Wash the fruit, peel oranges by hand and cut the lemons into slices by a sharp knife. Remove as far as possible the white shreds from the peel of two or three oranges and cut them into thin shreds of 1/32 inches thickness and 1—1½ inch length by means of a slicing machine. Tie these in a muslin cloth and boil along with the pulp. The pulp, peel and lemon slices are put into an aluminium pan and just enough water to cover the fruit is added to it. Boil for about half to three fourth of an hour to extract pectin. The acid helps the extraction of it. Carry out pectin test and on obtaining good pectin clot, strain the juice through a jelly bag. Wash the peel shreds tied in muslin cloth thrice in clean water and keep aside. If jelmeter is available read the correct amount of sugar to be added otherwise add sugar as per pectin clot obtained. The juice extract is brought to boil, required amount of sugar added gradually and stirred until it was dissolved, then strained through a coarse cloth and boiled vigorously until finishing point. The peel shreds are added a few minutes before the finishing point.

Marmalade prepared in this way will give a bitter taste and rich orange flavour and is very much relished by those who have acquired taste for it. Indians prefer a less bitter product, which could be prepared as follows:—Oranges and lemons are taken in the same proportion. Oranges are peeled by hand and peels of three oranges are cut into fine shreds and tied in muslin cloth. The shreds are boiled in water for half an hour or so till they become soft, taken out and washed thrice in cold water. The boiled water is thrown away. The peels of remaining oranges are cut into pieces and boiled in water just sufficient to cover the peel for ten minutes. Decant the water and add fresh water and sliced lemons. Boil again for half an hour and carry out pectin test. Strain the extract through a coarse cloth and add to this the pulp of oranges free from seed. Boil the mixture for 15—20 minutes. Strain the juice through a flannel bag and proceed in the same way as for above.

Guava jelly.--Take under-ripe sound fruits, wash clean and cut into small pieces. Add equal quantity of water and ½ to ¾ fluid ounces of lemon juice per pound of fruit to extract pectin. Boil for half an hour and carry out pectin test. Strain the juice and measure out extract. Add ¾ to 1 lb. of sugar per pound of juice extract according to the pectin clot obtained. Heat slowly till sugar dissolves and strain again if necessary. Then boil vigorously till jellying point, skimming being done frequently. Fill in hot sterilized jars and allow to set. Jelly of apple, papaya, wood apple (*Feroina elephantum*) karwand, jamun etc. could be prepared in the same manner. The quantity of lemon juice can be adjusted according to the acidity of the fruit.

Mango jam.—Take big sized raw mangoes, wash them and boil in water till soft. Scoop out the pulp and pass it through a sieve to remove fibres. Weigh the pulp and add equal quantity of sugar, cook till the mixture thickens or to 220° F. Stir constantly, fill in hot sterilized jars. Jams could be made out of papaya, wood apple, apple, plum and gooseberry. Lemon juice or citric acid solution must be added to fruit deficient in acid before cooking the jam.

Principles of preserve making.—The usual process for the preparation of fruit preserves consists in boiling the fruit in syrup until a syrup of heavy density is obtained and the fruit is thoroughly impregnated with the syrup.

Selection and Preparation of the fruit.—The fruit should be firm and sound in condition. It is prepared for preserving in the same manner as for canning. It may be punctured in numerous places by a silver fork or wooden tooth pick, if necessary, so as to allow easy and uniform penetration of the syrup.

Boiling the fruit.—It is then boiled in water or blanched in steam for a few minutes to make it just tender. Steam blanching is conveniently done by spreading a piece of muslin cloth over a boiling pan containing water. The muslin cloth is fastened in its position by a strong thread. The fruit to be steam blanched is placed over the muslin cloth and is covered by a plate. The boiling pan is then placed on an oven and the water allowed to boil. The steam evolved blanches the fruit, condenses into water and trickles back into the pan. Steam blanching softens the fruits and also helps in removing the strong flavour e. g. astringent taste of amla or karwanda, acidic taste of raw mango.

Preparation of syrup.—Sugar syrup is prepared by dissolving 2 or 3 lbs. of sugar as required in one pound of water. The mixture may be kept on fire and stirred well till the whole sugar dissolves. Skimming is done frequently to get a clear syrup. Milk diluted with equal volume of water is a good clarifying agent. A little mixture is sprinkled over the syrup two or three times and the scum is removed. After a few minutes of cooking the syrup becomes clean and reaches the consistency of honey. It should not be cooked beyond that stage as otherwise the syrup becomes sticky.

Cooking the fruit.—The prepared fruit is then poured in the hot syrup boiled and stirred well for 3—5 minutes. The pan is then removed from the oven. Care is taken not to caramalize the sugar by over cooking. The fruit should retain most of the colour of the fresh fruit and should remain plumpy or crisp.

Filling and storing.—The preserved fruit is filled hot in big jars and then cooled as quickly as possible so as to retain the fresh flavour and colour of the fruit.

Recipes.—The following recipes for preserve making have been found to give excellent results.

Mango preserve.—Mangoes are available in plenty in the season and excellent preserve is made from it. Usually housewives prepare these preserves in the month of June i. e. after the break of monsoon. There are two types of products (1) Preserved mango shreds, (2) Preserved mango slices. The former is usually prepared out of ordinary mangoes while the latter out of grafted mangoes which are free from fibre. As a matter of fact both the products could be prepared out of ordinary or grafted mango. Preserve from grafted mango is always superior in quality. Preserved mango shreds are prepared as follows:—Take big sized raw and sound mangoes free from fibre. Wash them well in water, peel them and cut into shreds on a shredding machine. Take 3 lbs. of sugar for every pound of shreds and prepare syrup as described above. Add shreds when the syrup acquires the consistency of honey. Stir for five minutes and remove the pan from fire. Fill it in big glass bottles or china clay jars, cool and cork. Preserved mango shreds are prepared in in gur as well. It gives a peculiar aroma, is slightly more acidic and is relished by many. The shreds are prepared in the same way. Two and a quarter pounds of good quality gur is taken for every pound of shreds and syrup prepared. No clarification is done. Rest of the process is the same.

Preserved mango slices.—Take good raw sound grafted mangoes, wash, peel and slice evenly to proper shape by means of a sharp knife. Steam blanch for ten minutes. Spread the slices after blanching on a clean muslin cloth and puncture in numerous places with a silver fork. Take 2 lbs. of sugar for every pound of slices and proceed in the same way as for mango shreds.

Orange preserve.—Take big sized sound ripe oranges. Peel and wash segments as well as hands to remove the bitter orange oil sticking to them. Remove the white skin adhering to the individual segments. This is a delicate job and should be done very carefully. Prepare sugar syrup by dissolving one pound of sugar in one pound of water. Put the segments in hot syrup and keep for 24 hours. Next day drain the syrup, add 1 lb. sugar and dissolve it, thus taking 2 lbs. of sugar for every pound of segments. Prepare sugar syrup of the consistency of honey and add orange segments to it. Boil for three minutes and remove the pan. Fill in big jars and cool.

Apple preserve.—Take big sized apples, peel and slice them. Keep the slices immersed in dilute 1% brine solution to prevent oxidation and browning. Puncture in numerous places by silver fork. Steam blanch for five minutes or so, till they become soft. Take 2 lbs. of sugar for 1 lb. of slices and follow the same process.

Awla preserve.—Take big sized fruit, wash clean, puncture in numerous places by a silver fork. Soak them in water for one to one and a half hour, and boil for about half an hour till they become soft but before they begin to break away from the seed. Boiling takes away the astringent taste of the fruit. Take 3 lbs. of sugar for 1 lb. of boiled fruit. Prepare syrup and follow the same process as for mango. Awla preserve has a high medicinal value.

Karwand preserve.—Take big raw sound fruit and give a slight vertical cut for taking out seed. Remove the seed and steam blanch the fruit for about five minutes till it is partially soft. Take 2½ lbs. of sugar for every pound of seedless fruit and proceed as for mango.

Preserve could similarly be made out of various other fruits.

Principles of making candied fruit and peel.—The candying process consists essentially of slowly impregnating the fruit with syrup until the sugar concentration in the fruit is high enough to prevent spoiling.

Selection and preparation of fruit.—The fruit should be firm, sound ripe. It is punctured in numerous places with a silver fork or a needle or a sharp wooden tooth pick so that a syrup can penetrate uniformly and easily to the centre of the fruit.

Boiling the fruit.—It is then boiled for a few minutes to make it just tender. Too much cooking will spoil the shape and texture, too little will result in slow penetration of the sugar and toughness of the fruit.

Preparation of the syrup.—For every pound of fruit ¾ lb. of sugar is dissolved in 1½ lbs. of water. The hot syrup is poured over the fruit and allowed to soak into it for 24 hours. It may be necessary to tie the fruit in a muslin cloth and place weight over it to keep it submerged under syrup. After 24 hours the syrup is drained off and 3 ozs. of sugar dissolved in it. It is then brought to boil and poured over the fruit. It is allowed to soak for another 24 hours. This process is to be repeated every day for three successive days and then 6 ozs. of sugar is added on alternate days, instead of three ozs. every day. It will take about 8—10 days for the syrup to reach the consistency of honey. Such a syrup contains about 70—75% sugar. Finally the fruit is immersed into this syrup and kept for three days.

Drying the fruit.—The fruit by now is thoroughly impregnated with sugar. It is removed and placed on a wire screen to drain off all the syrup. It may then be dried in an oven with a temperature not exceeding 120° F or in bright sun till the outside of the fruit ceases to be sticky. While drying the fruit should be carefully turned over so that it may become uniformly dry. It is then stored in glass bottles or cardboard boxes.

Glace or crystallized finish.—If a better finish is desired the fruit may be dipped in a fresh syrup to give either a glace or transparent or crystallized finish. For this purpose the same syrup should not be used as the sugar undergoes a chemical change due to fruit acids and therefore does neither crystallize nor give a glace or transparent finish. For glace finish a syrup is prepared by dissolving 2 lbs. of sugar in 1 lb. of water. A small quantity is taken in a cup and pieces of candied fruit are dipped into it with a fork or spoon and then placed on a wire tray. As soon as the syrup looks cloudy it should be discarded and a fresh syrup taken. The syrup is kept warm throughout otherwise sugar crystallizes down. When all the fruits have been dipped and placed on the wire tray, the tray should be transferred to an oven or in the sun for drying.

For crystallized finish.—The syrup should be prepared as for glace finish. Candied fruit is transferred on a wire tray placed in a deep enamel pan. Sugar syrup is poured in the pan until the fruit is completely immersed in the syrup. Another wire tray should be placed on top of the fruit to keep it under the syrup. The fruit is left in syrup from 12—18 hours and then carefully removed by raising the wire trays out of syrup. Allow the syrup to drain out completely and then dry the fruit in an oven or in the sun.

Recipes.—The following methods have given very satisfactory results. Candying Ber (*Ziziphus jujube*)—a grafted variety known as Nagpur Ber grows luxuriantly and bears in abundance in this province. It is sold so cheap in the market that neither growers consider it worth while to include it in regular orchards nor consumers take fancy for it and use it on the table. A great deal of fruit is of course wasted. Ber could be nicely candied for home use and the method is as follows:—

Select fruits of large size, free from blemishes and insect attack. Puncture them all over with a silver fork or sharp wooden tooth pick and tie them in a muslin cloth. Immerse them in boiling water for five minutes to soften them and facilitate the penetration of sugar syrup. Prepare sugar syrup as stated above and pour it over the bers until all fruits are submerged under the syrup and then keep aside for 24 hours. Repeat the process as mentioned for 8—10 days increasing the concentration of sugar till it reaches the consistency of honey. Dry the fruit in oven or under sun.

Candying ginger.—Candied ginger is a very useful article in the household due to its medicinal value. Select tender ginger, wash clean of all dirt and cut into uniform oval shaped pieces. Skin them and puncture all over by a silver fork. Steam blanch for about two hours in order to soften the pieces and to remove the sharp pungent taste. If pressure cooker is available blanch them under pressure of 10 lbs. for about half an hour. Prepare syrup by dissolving 1 lb. of sugar in 1½ lbs. of water. This is sufficient for 1 lb. ginger pieces. Bring to boil and immerse the pieces in it and keep aside for 48 hours. Drain the syrup and dissolve 8 oz. of sugar. Boil ginger pieces in the syrup for 3—4 minutes and keep aside the mixture for 4 hours. Proceed as above till the syrup reaches the consistency of honey. Remove the pieces and dry them on wire screen.

Candied orange peel.—It is used in cakes and could be prepared very cheaply. Wagon loads of dried orange peel are exported from Nagpur to Bombay for preparation of candied orange peel. In the process of manufacturing squashes candied orange peel could be a useful by—product. Wash peel in clean water and remove any white shreds sticking to the inside of the peel. Cut them into thin shreds of required thickness. Soak them in hot solution of 2% bicarbonate of soda for about 15 minutes. Remove the skins and rinse them thrice in cold water. They are then simmered gently in fresh water for about 10 minutes until they are quite tender. Syrup is prepared by dissolving 1 lb. sugar in 1 pint water. Bring it to boil, place the peel into it. Leave to soak for two days. Drain the syrup after that period and dissolve 8 oz. of sugar in it. Add peel and boil gently for 3—4 minutes. Keep aside for 2 days. Remove the peel and place it on a wire tray and dry in the sun.

Use of syrup.—The excess syrup that remains after the process of candying is of the consistency of honey and has a delightful flavour of the fruit that is candied in it. It can be utilised over and over again for candying if it is sterilised at 190°F for 15 minutes and stored in a bottle for use later on. A small portion may be taken out and diluted with 2½ times the volume of water to give a syrup of about 25 percent concentration. This syrup can be used for candying a fresh lot of the same kind of fruit. The concentration of this syrup can be gradually increased as stated in the process by the addition of a small amount of syrup instead of sugar day after day. The syrup may be used for sweetening, puddying and fruit chutney of various kinds. It can also be used for toffee making with the addition of a little butter.

HINTS ON "HUMAN NUTRITION"

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It is needless to emphasise the importance of researches in human nutrition. Everyone desires to have good health and long life. These are however dependent on proper nutrition. Researches carried out in this direction, in different parts of the world, including work done at the Nutritional Laboratories, Coonoor, India, have given out useful information for the welfare of the human population of the world. The object of this paper is to give a few useful hints on human nutrition in our country chiefly based on the collection of material from the Nutritional Laboratories, Coonoor, India.

Dietary requirements.—The following groups of substances are required for the nutrition of the human body :—

1. Proteins	Energy yielding factors.
2. Fats	
3. Carbohydrates	
4. Minerals	Important in the physiological functions of the body.
5. Vitamins	
6. Water —	Necessary diet element.

Calories in diet.—The first essential of the diet of any person is its energy value which is expressed in terms of calories. Everyone must get enough quantity of food daily to yield the required number of calories of heat for maintenance and work. The human body has a remarkable faculty to adopt itself to semi-starvation, and many people who are underfed, scarcely realize this fact. An expert Commission of the League of Nations has drawn up the following scale:—

An adult not engaged in work ... 2,400 Calories per day.

Supplements to the above may be added:—

Light work	... 75	Calories per hour
Moderate work	... 75—150	„
Hard work	... 150—300	„
Very hard work	... 300 and upwards.	

These figures have been found to be somewhat high for the warm climate of our country. The following scale of average calories requirement is considered to be suitable for our country:—

Scale of average calories requirements

Age	*Calories required per day*
Adult male (over 14) engaged in moderate work	2,600
Adult female (over 14)	2,080
Child 12 and 13 years	2,080
Child 10 and 11 years	1,820
Child 8 and 9 years	1,560
Child 6 and 7 years	1,300
Child 4 and 5 years	1,040
Child 2 and 3 years	780
Child 0 to 2 years	520
Male of sedentary occupation	2,150
Male engaged in heavy manual work	2,800—3,000
Pregnant woman	2,400
Nursing woman	3,000

It is usually better to err on the side of excess by 100—150 calories to allow for water of all kinds, including the inevitable leakage of food.

Protein.—The next step in constructing a balanced diet is to ensure that it is satisfactory in quality. Protein is most important of the food factors. It supplies building material for the body and makes good the loss of tissue which occurs as the inevitable result of living at all. It can also be used by the organism as a source of energy. Requirement of protein is greater during growth, pregnancy and lactation.

Protein requirements

Age & Sex		*Grammes per day*
Man	18 to 60	65
Woman	18 to 60	55
Boy	10 to 17	80
Girl	10 to 17	70
Child	6 to 9	60
Child	2 to 6	40—50

All common food-stuffs contain protein, but the amount they contain varies widely. The outer layers of the grain are richer in protein, and when wheat and rice are highly milled, there is some loss of protein. Pulses are richest in protein. Animal foods such as milk, eggs, fish and meat are rich in protein. It is recommended that at least one-fifth of the total protein in the diet should be derived from animal source as this protein contains amino acids essential for building work of the body. The best source of animal portein is **milk**. Skim milk and buttermilk of good quality are also useful sources. Eggs, fish, liver and muscle meat also contain proteins of high biological value. In our country, the inclusion of animal protein in adequate amounts is the point which presents the greatest difficulty.

Fat.—Fat is a concentrated type of fuel for the supply of energy to the body. Not less than 45 to 60 grammes (1½ to 2 ozs) of fat should be consumed daily. Supply of fats from animal source such as butter and ghee is very important, as these contain Vitamin A. Other vegetable oils except red palm oil do not contain Vitamin A. Red palm oil is obtained from the fruit of the red palm *elaeis guineensis* grown in West Africa, Malaya and Burma. All oils, fats and nuts are useful in supplying the fat element to the body. A more liberal supply of fat than the prescribed minimum is however desirable.

Carbohydrates.—Carbohydrates are the body's chief source of energy. Grain foods and root vegetables are rich in this element. Sugar is wholly carbohydrate. After deducting the calories of food supplied by protein and fats, all the remaining calories have to be supplied by carbohydrate. For all practical purposes, each grain of protein or carbohydrate supplies 4 calories of heat, while each grain of fat supplies 9 calories of heat. Protein is chiefly supplied for constructional purposes, but for the purposes of estimation of the calories in a diet, its energy value is taken into consideration.

Minerals.—Minerals are important in the physiological functions of the body. Calcium and phosphorus are required for the formation of bones.

Usually it is assumed that if the diet is well balanced, enough of these elements will be obtained. The following minerals are however more important and it is probable that these are insufficiently supplied by average diets in our country.

Calcium.—Calcium is found abundantly in milk, skim milk, buttermilk, and green leafy vegetables. Children, expectant and nursing mothers require more calcium. Text book figures representing calcium requirements are 0.68 gram daily for adults and 1.0 gram for children. Diets based on milled rice, may supply less than 0.20 gram of calcium daily. The best source of calcium is milk. Green vegetables and certain millets e. g. *ragi* are also rich in calcium.

Phosphorus.—If a diet contains sufficient calcium, it may be taken for granted that its phosphorus content is satisfactory. Over 1 gram of phosphorus should be supplied by the diet daily. Cereals are fairly rich in phosphorus, but considerable loss of this element occurs on cooking.

Iron.—Haemoglobin, the red pigment of blood contains iron as an essential constituent. Iron is needed by the body for blood formation. When destruction of blood corpuscles takes place in chronic malaria and hook worm, iron requirements are increased. For the prevention and cure of anæmia, an iron-rich diet is valuable. Daily diet for a growing child or an adult should contain 20 mgms of iron.

Iodine.—Requirement for iodine varies between 32 to 66 micrograms per adult per day. It is of special importance in goitrous areas. Iodine, as a supplement, may be given in form of potassium iodide solution 1 in 100,000 parts of water.

Vitamins.—The word "Vitamine" was coined in 1912 by Casimir Funk, a Polish scientist then working in London. "*Vita*" implied "*Necessary for life*". The ending "*amine*" indicated that the substances in question were organic bases. Later it was found that this assumption was unjustified and in 1918 Professor J. C. Drummond proposed that the final "e" should be dropped. Funk, writing in 1922, remarked, "I must admit that when I chose the name Vitamine, I was well aware that these substances might later prove not to be of an amine nature. However, it was necessary for me to choose a name that would sound well and serve as a catch-word". Funk's choice of a good "catch word" has proved of importance in creating public interest in nutrition. Now, a number of vitamins have been isolated, synthesized and their importance in human nutrition known. The following are however more important, and it is probable that most of these are insufficiently supplied by average diets in our country.

Vitamin "A".—Vitamin A—$C_{20}H_{30}O$ and its precursor carotine $C_{40}H_{56}$ have the same physiological action. Carotine is converted into vitamin A in the liver. This is present in animal fats such as butter, ghee and fish liver oils like codliver oil and Halibut liver oil. It does not occur in foods of vegetable origin, but substances called carotines from which vitamin A is readily formed in the body occur in vegetable products, especially in green leafy vegetables and most yellow vegetables and fruits such as carrots, papayas, mangoes and tomatoes. Red palm oil also contain carotines. A well balanced diet should contain a daily minimum of 3,000 international units of vitamin A. Three ounces of amaranth leaves or other similar good leafy vegetables will supply more than 3,000 international units. Butter contains 10 to 60 international units per gram. Ghee from cow's milk contains 10 to 30 international units per gram. Ghee from buffalo milk contains 3 to 6 international units per gram. Prolonged heating of ghee in an open pan may cause reduction of vitamin A. Vitamin A content of milk and butter fluctuates according to the diet of the animals from which the milk is derived. Milk obtained from animals fed on succulent green grass and kept under natural healthy conditions contains more vitamin A. 100 grams of cow's milk would yield 180 international units.

Deficiency of Vitamin A in the diet causes the following diseases:—

(1) Night-blindness—It is an early sign of malnutrition.

(2) Bitot's spots.—They are white chalk-like areas on the white of the eye.

(3) Xerophthalmia—There is thickening and yellowish brown discolouration of the membrane covering the inner and outer parts of the white of the eye.

(4) Keratomalacia—In this, there is softening and degeneration of the transparent front of the eye, leading at first to temporary and later to permanent blindness. It is often caused in infants deprived of milk.

(5) Phryno-derma or toadskin.—In this the epithelium becomes dry and keratinised. It is best seen round the elbows. The skin is dry.

Vitamin A is considered necessary for growth.

Vitamin B_1.—Vitamin B_1 is 'water soluble' and is widely distributed in nature. It is found in abundance in yeast, eggs, cereal integuments (germ and pericarp), legumes and green vegetables. Milk and meat are not rich sources. Cereal endosperm is deficient in this factor. The outer parts of grains contain this vitamin and minerals, and hence when rice is highly polished, it is deficient in these. Parboiling rice distributes the vitamin and mineral into the interior of the grain, and therefore polishing parboiled rice does not remove these important nutrients. Three hundred international units of this vitamin are required for school children and adults per day. If 4 ozs of unmilled cereal, 6 ozs of leafy and other vegetables and 2 to 3 ozs of pulses are consumed daily, it is probable that enough vitamin B_1 will be obtained, even if the rest of the diet is composed of milled rice. Washing of rice before consumption removes a great portion of this vitamin.

A deficiency of this vitamin in the diet leads to:—(1) General ill health, (2) when the deficiency is great, it is followed by a paralytic disease called beriberi. Beriberi is common in areas where milled and polished rice is the staple food of the people; (3) Infantile beriberi is caused by deficiency of this vitamin. It usually occurs in the breast fed infants of ill nourished rice-eating mothers. It is cured by "Tiki tiki"—an extract of rice polishings, (4) Vitamin B_1 is also concerned with carbohydrate metabolism.

Vitamin B_2.—B_2 (a term covering serural vitamins) is a water soluble vitamin. All cereals and fruits are poor sources of this vitamin. Pulses, green leafy vegetables, certain roots and tubers, yeast, milk-products, lean meat, liver and eggs are good sources of this vitamin.

Deficiency of this vitamin causes the following ailments:—

(1) Pellagra.—This is very rare in India, but the maize eaters whose diet is deficient in meat, eggs, vegetables etc., tend to develop pellagra. Dermatitis, diarrhoea and dementia are the ailments of pellagra. The pellagra preventive factor is one of the elements in B_2 complex.

(2) Stomatitis.—This is the most common food deficiency disease in India. In this, there is 'soreness' of the angles of the mouth and the tongue. This is common among rice-eaters whose diet is deficient. The disease is cured by giving ½ to 1 oz of dried yeast or ½ to 1 pound of good milk or 2 to 3 eggs daily to an adult.

(3) There is a possible relationship between B_2 deficiency and certain types of anæmias of pregnancy which can be cured by autolysed yeast extract (marmite).

(4) This vitamin is also concerned with general health and developments. One of the reasons why milk is so effective in improving the health and development of children, is its richness in the vitamins of this group.

(5) Besides the pellagra preventive factor and the anti stomatites factor, there are also present other factors in this group of the vitamins, whose relation to human nutrition is not yet very clearly known.

Vitamin C—This is a water soluble vitamin. A well balanced diet for school children and adults should contain some 30—50 mgms, of vitamin C per day. Fresh fruits like oranges and lemons, amla (*Phyllanthus Emblica Lynn*), green leafy vegetables, sprouted pulses, and chillies are rich sources of this vitamin. One amla supplies vitamin C equal to the quantity contained in two oranges. Amla tablets have been made to supply vitamin C to troops. Pulses and cereal grains in the ordinary state contain no vitamin C. When they are allowed to sprout, the vitamin C is found. The sprouted grains should be eaten raw or after cooking for not more than 10 minutes. Sprouted pulses may contain 10—15 milligrams of vitamin C per 100 grams. Vitamin C is sensitive to heat, and loss occurs in cooking. Milk is not a rich source of vitamin C. In the case of infants fed on boiled milk special attention to vitamin C requirements is necessary. These can be met by giving fruit juice in small quantities. A deficiency of this vitamin causes loss of energy, and a disease called scurvy follows. Conspicuous sensitiveness, stiffness in the joints, loss in weight and sallow muddy complexion are the chief symptoms of scurvy. Rheumatism in infants and young children is really scurvy.

Vitamin D.—This is a fat soluble vitamin. It is found in liver, liver oils, egg yolk, and in milk and milk fat obtained from animals feeding on green pastures and exposed to sunlight. Fish liver oil is its richest source. Vitamin D is formed in the skin and absorbed into the circulation when a person is exposed to sunlight. It is important that children should be allowed to play in the open for an hour or two each day, Excessive exposure to sunlight is not however necessary in the tropics. The custom of oiling the bodies followed by exposure to the sun for sometime is good.

Deficiency of vitamin D causes rickets in children and ostiomalacia in adults. There is a close connection between vitamin D and calcium and phosphorus requirements. Vitamin D helps to ensure the development of strong regular teeth. A good supply of this vitamin during pregnancy benefits the mother and helps to ensure the satisfactory future development of the child. The cheapest and easiest way of supplying vitamin D is by exposure of the body to sunlight.

Vitamin E.-Vitamin E is fat soluble antisterility factor. Its chief sources are grains and vegetables. It is found in wheat germ, rice-germ, cotton seed, lettuce, butter and eggs. Wheat germ oil is a rich source of this vitamin and it has been used as a curative medicine against sterility with successful results. Vitamin E is however widely distributed.

Vitamin K.—Vitamin K is fat soluble, anti-hemorrhagic factor. It is found in Alfa-alfa, tops of carrots, sprouted peas, inner leaves of cabbage, spinach, cauliflower, sea-weeds and soyabean oil.

There are a few other vitamins which belong to the B_2 complex group. Their relation to human nutrition is not yet fully understood.

MALNUTRITION

Malnutrition is very common in our country. It has far-reaching effects when it is present during infancy, childhood and adolescence. Malnutrition in the expectant and nursing mother endangers the lives of both mother and child. There is a long list of diseases, due in some way or other to dietetic causes. Many of these diseases have already been mentioned. Malnutrition is associated with general ill-health, lowered bodily resistance, and a greater liability to disease. This is a vicious circle; malnutrition lowers the individual's resistance to disease; disease makes him less capable of efficient work and this causes greater poverty; and greater poverty increases malnutrition. This malnutrition and disease weaken the race and lower its vitality and earning capacity. Malnutrition is a national problem.

Apart from poverty, ignorance of the principles of nutrition has caused a great deal of suffering. Spread of the required knowledge is therefore very essential.

PLANNING OF DIETS

A concrete example will illustrate the methods to be followed in improving diets and drawing up satisfactory diet schedules. The following diet is a typical diet consumed per day by poor people in rice eating areas:

Name of foodstuff	*Quantity*	
	lbs.	ozs.
Milled rice ...	0	15
Milk ...	0	1
Pulses ...	0	1
Brinjal ...	0	1
Ladies fingers ...	0	0.5
Amaranth ..	0	0.25
Oil ...	0	0.5

This diet would yield the following quantities of the different nutrients:—

Name of nutrient	*Quantity*
Protein	... 38 gms.
Fat	... 19 ,,
Carbohydrate	... 357 ,,
Calories	... 1750 ,,
Calcium	... 0.16 ,,
Phosphorus	... 0.60 ,,
Iron	... 9.00 mgms.
Vitamin A	... 500 International units.
Vitamin B_1	... 160 ,, ,,
Vitamin C	... 15.0 mgms.

From the above it is apparent that this diet is insufficient in quantity and that it fails to supply the necessary requirements of any of the food factors enumerated before.

The following adjustments might be made to make it adequate and " well balanced " :—

Name of foodstuff	*Quantity* lbs.	ozs.
Raw milled rice ...	0	10
Bajra or any other millet ...	0	5
Milk ...	0	8
Pulses ...	0	3
Non-leafy vegetables ...	0	6
Leafy vegetables ...	0	4
Oil ...	0	2
Fruit (mango, ripe plantain, etc.).	0	2

The nutritive value of the above diet is as follows :—

Name of nutrient.	*Quantity.*
Proteins	73 gms.
Fat	74 ,,
Carbohydrate	408 ,,
Calories	2590 ,,
Calcium	1.02 ,,
Phosphorus	1.47 ,,
Iron	44.00 mgms.
Vitamin A	over 7000 International units.
Vitamin B_1	over 400 ,, ,,
Vitamin C	about 170.0 mgms.

This diet contains enough calories to supply the requirements of an average man. All the important food factors are present in sufficient quantities, with a fair margin of safety. The chief cereal in both the diets is milled rice. If, however, the staple cereal is whole wheat or hand pounded rice the diet would be much better. Millets like *juari* and *Bajra* are good sources of vitman B_1. They are particularly useful when milled rice is the main cereal in the diet.

A liberal, better, but more costly diet may yield the following:—

Proteins	—	90	gms.
Fats	—	80	,,
Carbohydrates	—	480	,,
Calories	—	3000	

and a liberal supply of all the vitamins.

In the above one-third protein and half of the fat are derived from the animal source, i. e. either from milk and milk products or from eggs, fish and meat in case of non-vegetarian diet.

IMPORTANT POINTS

(1) Milk, curd, ghee and other milk products are most important. Milk is costly but buttermilk and skim-milk are not so costly. Supply of even 8 ozs of skim-milk per head, to children has shown great improvement. Consumption of milk-products is most important. In the vegetarian diet, animal protein and animal fat are derived from milk and milk products only.

(2) Breast feeding of children is the best. Mother, of course, should be suitably nourished. Children, pregnant and nursing mothers deserve special attention.

(3) Supply of a small quantity of oil in place of cereal is important. Supply of butter fat through milk, butter or pure ghee is very important.

(4) Milled rice may at least be partly substituted by whole rice, whole wheat or one of the millets. Parboiled rice is superior to milled rice. Millets are usually cheaper and their use should be encouraged.

(5) Washing rice several times removes most of the vitamins and minerals.

(6) Water in which food is cooked, should not be discarded or strained away.

(7) Addition of alkali in cooking, decreases the nutritive value of food.

(8) Pulses are rich in proteins and in the B vitamins. 2—3 ozs of a pulse should be given to an adult per day. Use of sprouted pulses is very beneficial.

(9) Use of green leafy vegetables should be encouraged. Each adult should get 4 ozs of leafy vegetable per day. The cheaper varieties are as good as the expensive ones.

(10) Tomatoes, oranges and other juicy fruits are rich in vitamins. Such fruits should be eaten daily.

(11) Sun-bathing is good. It is essential for preventing rickets and ostiomalacia.

(12) During cooking, vessels should be kept covered, to prevent losses by oxidation. Cooking should not be unnecessarily prolonged.

(13) Occasional use of eggs, liver, meat or fish is good, if religion permits their use.

Those, who do not use these, must pay speical attention to include milk, pure ghee and other milk products in their diet.

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RECENT METHODS IN PLANT BREEDING

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From time immemorial man has obtained his food either immediately or ultimately from plants. This is enough to show as to how human attention has been attracted to improve at best such plants which are daily used by him. Sporadic attempts have been made to devise means for improving the crop plants from time to time in times of yore but it was not till the nineteenth century when Shirref, Knight, Le Couter and Vilmorin hit upon single plants selection as the means of improving crop yields. This period could be said to be the period when the art of plant-breeding took a definite shape. Definite methods were then evolved to achieve this aim.

The first method consisted in introducing economic plants from one locality to another where hitherto the plant in question has not been grown. Thus potatoes were introduced in the year 1857 in Europe from South America. The second practical method which has given very successful results is the method of selection. This has got its own technique and limitations. The chief trouble in this method is the difficulty of distinguishing between variations that are heritable and fluctuations that are not heritable.

In marked contrast to these methods were those of Mendel. In his private garden he commenced experiments on hybridisation on garden peas. The results of ten years work on this plant was published in 1866 as a brief paper in the Naturalist Society of Brunn. This work has been highly appreciated after the death of Mendel and a paper was rediscovered by Hugo de Vries, Correns and Tschermak. Based on Mendel's discovery it was then possible for the scientist to produce variations or to combine characters in plants according to their will. The technique requires, of course more skill and has more limitations also.

Besides these methods, there are certain changes which are always caused in hereditary units of plants, in the environment in which it is placed; thus new plants are evolved, but this takes a very long period and sometimes these changes may not fulfil the economic needs of human beings.

The scientists have now added very valuable methods which are more quick and which can yield results of great economic value in a comparatively shorter period of time. They are by the use of :—

(1) Chemicals, (2) Radiations, (3) Temperature, (4) Twin seedlings and (5) Decapitation.

1. **By Chemicals.**—This is a very effective and up-to-date method, used in modern times to produce a number of mutations in the plant kingdom. Many chemicals have been used for this purpose, and important of them are:—Colchicine, Acenaphthene, Chloral hydrate, Ether, Chloroform, Alcohol, Nicotine Sulphate etc.—of these Colchicine heads the list It has produced polyploids successfully in a large number of families and its list is every day increasing. Second comes acenaphthene and the rest are not much in use.

These chemicals are applied in various forms and concentrations, according to the material treated. For example colchicine is applied in solution and the concentration varies from 0.025% to 2% while Kostoff (1938) has used acenaphthene in crystal form in varying amount. Similarly period of treatment and method of treatment will also vary according to the material and chemical used. The methods used can be summed up as follows :—

i. By treating the seeds,
ii. By treating the inflorescence,
iii. By treating the stems,
iv. By treating the roots by hormones to stimulate root formation,
v. By inducing abnormality in pollen tube growth.

i. Polypoids have been obtained by immersing seeds in various concentrations of colchicine for different periods in til (*Sesamum Orientale linn*) (Richharia and Persai 1940). When seeds are fed on colchicine solution of different concentrations, abnormalities in seeds resembling to polyploidy are noticed.

ii. Leven has produced tetraploid in sugar beets by inflorescence treatments with colchicine. The buds in the inflorescence are brought in contact with the desired strength of colchicine, chloroform, chloral hydrate etc. solution by putting it in a tube closed at one end and immersing the inflorescence in it for the required period. Then the chemical is removed and the inflorescence is washed with tap water and left to grow. In this method the meiotic process is disturbed, giving rise to gametes with varying number of chromosomes. Thus mutants are produced.

iii. The chemicals known as plant hormones are capable of producing polyploid cells when applied to a cut surface of the stem. This has been described under method No. 5 i. e. Decapitation. There are many plant hormones and a few important are as follows :—

(Beeta).—Indolyl-acetic acid,
(Beeta).—Indolyl-propionic acid,
(Alfa).—Naphthalene-acetic acid etc.

Injection of certain chemicals in stems as colchicine or chloral hydrate may also give polyploid cells giving rise to mutants.

iv. It has been observed that whenever the seeds are treated with a chemical more specially colchicine the root development is retarded to a varying extent in some varieties of til. The higher the concentration the more the retardation of root growth. If the roots can be induced in them, some of those will give polyploids of very interesting nature. Besides acetic acid, chemicals such as (1) Indolyl-butyric acid, (2) Indolyl-acetic acid (3) Naphthalene-acetic acid, have been known recently to stimulate root formation. Roots can also be induced in cuttings.

v. By the application of certain chemicals on the stigma soon after pollination abnormalities are introduced in the pollen tube growth e. g. Kostoff (1938) got abnormalities in pollen tube growth of *Nicotiana tabacum* by the application of acenaphthene.

2. **By Radiations.**—Like chemicals, this method has also given very fruitful results. The method consists in treating the plant at various stages with X ray, radium rays, ultra-violet rays, cosmic rays etc. Out of these X-ray and radium rays have given results of economic value when applied to young buds, mature pollen, dormant seeds and young seedlings.

Muller in 1927, was the first to change the characters by X-ray irradiation in Drosophila. Since then many works have been reported. Ramiah and Parthasarathy (1938) produced many mutations in rice which are promising well at Coimbatore by X-ray treatment. Chromosome abnormalities have been reported in several groups of plants i. e. barley, nicotiana, datura, allium, etc. The abnormalities are chiefly the segmental interchange, fragmentation, translocation etc. The two important works of this method are, Stadler (1928) on barley and Gager and Blakeslee (1927) on datura. Both of them got mutations of various kinds by giving varying treatments.

Ultra-violet rays, cosmic rays etc. have also been reported to induce mutations.

3. **By Temperature** —Recently, application of temperature (high or low) has been a very successful method of producing mutations. There are three convenient stages at which it can be applied :—

(1) At germination period
(2) At meiosis
(3) At the first division of the zygote.

The first method has not been tried extensively up till now. But morphological variations have been known to occur when the germinating seeds are exposed to high or low temperatures. This method provides a wide scope for investigation.

The second method has great potentialities. After ascertaining the exact size of the bud in which meiosis is going on, the buds are subjected to high or low temperature treatments. This results in irregular meiosis, giving rise to gametes with various number of chromosomes and ultimately to various mutations.

The third method has been extensively tried and interesting results have been obtained by Randolpti (1932) in maize and Dorsey (1936) in some cereals. In the first case the temperature was raised to 38°C—45°C. and in the second to about 43°C. The plants soon after fertilization, when they begin to divide, are exposed to high or low temperature which duplicate the chromosome number. Thus tetraploids have been obtained in *Triticum durum, Triticum vulgare* and few others by high temperature treatment. Muntzing (1937) also obtained a seedling of *Triticum turgidum* with doubled chromosomes by low temperature treatment.

The mutants or polyploids thus obtained may not always be fertile and therefore necessary improvement should be effected by further breeding work.

4. **By Twin seedlings.**—This is a simple modern method of getting mutants. Presence of more than one embryo in a single seed is known as Polyembryony and the seedlings thus got are called twin seedlings. These individuals or twins are not always normal. Some of them may be haploids and hetraploids. For example in rice two or three seedlings from single seeds have been recorded and a haploid was obtained in association with a diploid (Ramiah, Parthasarathy and Ramanujam, 1935). But the frequency is very low and Muntzing (1937) records it approximately one per thousand. He also records the twin seedlings with different chromosome numbers in few species. Occasionally haploids and tetraploids are also observed.

For obtaining the twins, the seeds are germinated on moist blotting-paper and whenever the twins are found, they are separated carefully from each other by a sharp knife and planted separately. With the help of external morphological characters and the chromosome counts, the various types of twins will be isolated and found if they are mutants. The presence of mutants in these twins is already recorded above and since the phenomenon of polyembryony is fairly well spread in a large number of families, this method may be helpful in getting very useful mutants.

5. **By Decapitation.**—This method developed by Gorgensen consists in cutting back strong and vigorous seedlings upto a node by a sharp scalpel. A few days after, a callus is formed at the cut, from which many adventitious shoots are given out. Most of these shoots resemble the parent but some of them may have a different appearance. These may be removed and propagated in a suitable medium. Generally such plants are mutants (polyploids) possessing higher chromosome numbers. A change of sex in papaya from male to female by decapitation has also been obtained (Sarup and Manjumdar 1934). This method can be applied successfully in several groups of plants and requires its wide application.

Extracts

RICE IS INDIA'S LARGEST SINGLE CROP

" In recent years, rice has become the third most important food-grain in international commerce and ranks next to wheat and maize," states the Agricultural Marketing Adviser to the Government of India, in his report on the marketing of Rice in India and Burma, just published.

The chief importers of rice are the densely-populated Asiatic countries which grow insufficient quantities of this food-grain, to feed their inhabitants. For instance, although India and China account for practically two-thirds of the entire world production of rice, both import on a large scale to supplement their domestic supply. During the last 10 years India has imported from 1,500,000 to over 2,500,000 tons of rice every year.

Principal exporters.—The three principal exporters of rice are Burma, Siam and Indo-China. Of these, Burma comes first with an average annual export amounting to some 3,000,000 tons equivalent to about 30 per cent of the total world trade. About two-thirds of Burma's production of rice is shipped abroad and roughly half normally is received in India. The importance of the rice trade in the economic life of Burma may be gauged from the fact that the value of Burma's rice exports constitutes some 20 per cent of the total value of her exports and the greater part of the population is directly concerned in the cultivation, transport and milling of this cereal.

In point of acreage, production and total value rice is the largest single crop grown in India. The total area under this cereal is reported to be on an average not less than 76,260,000 acres annually, *i. e.* about 18 per cent of the total cultivated area and about 36 per cent of the entire acreage under food-grains in this country. The crop is grown mostly in Bengal, Madras, Bihar, Orissa, Central Provinces and Assam. Of these Bengal ranks first with over 21,000,000 acres.

According to available statistics, the average total production of rice in India amounted to 29,000,000 tons annually between 1927-28 to 1936-37. This quantity reckoned on an average price of, say, Rs. 3-8 per maund would represent a value of Rs. 2,760,000,000. Of the total production, 88 per cent was produced in British India and the remaining 12 per cent in Indian States.

Although India is stated to be the second largest rice-producing country in the world, she has a large import trade in rice, and during the period 1935-36 to 1937-38 imported rice to the value of roughly Rs. 132,500,000 annually.

Burma's exports.—On an average, during the last 10 years ending 1936-37, Burma produced annually 4,850,000 tons of rice. About 17 per cent of the total production is retained by the grower in Burma for domestic use, seed, etc., and the balance of 83 per cent constitutes the marketable surplus. During the period 1931-32 to 1938-39, the annual shipments of paddy and rice averaged over 160,000 tons and 2,930,000 tons respectively.

About 27,250,000 tons of rice are consumed in various cooked preparations in India the great bulk being in the form of plain boiled rice. The *per capita* consumption of rice for the whole of India is about 181 lb, per annum, the highest rate being in Bengal with a *per capita* consumption of 344 lb.

Of Burma's annual average production of 4,750,000 tons (for the three years ending 1936-37) approximately some 185,000 tons is used for seed and 1,480,000 tons for internal consumption, the remaining 30,80,000 tons being available for exports. The *per capita* consumption of rice in Burma is above 231 lb.

The report stresses the need for the standardisation of the qualities of rice in the interest of the producer, the trade and the consumer and describes it as one of the most urgent problems of rice marketing. With the object of bringing about some measure of uniformity in the undefined qualities of rice normally put on the market, measures have been taken under the Agricultural Produce (Grading and Marketing) Act, 1937, to draw up standard grade specifications in respect of a number of commercial descriptions.

Storage of Paddy and Rice.—There are different methods of storing paddy and rice in India. Wooden bins are frequently employed for keeping the grain especially in Assam, Bombay and the States of Kashmere, Mysore and Travancore. Home-made structures of straw and bamboo splits are by far the most common. Receptacles made of mud or brick work are used in the United Provinces, Central Provinces, Bombay, Bihar and Mysore. Even ordinary pits are used by the cultivators in Orissa, Madras Presidency and some parts of Bihar. In markets, the common storage is the masonry godowns in which paddy in generally stored in bulk and rice in bags. A little over 1 per cent of the average production of the Indian rice crop valued at Rs. 30,200,000 is wasted every year through weevil infestation, dampness and vermin attack. In Burma, circular baskets and rectangular godowns made of plaited bamboo are used for storing paddy in the villages, while mill godowns and those of the larger stock-holders are usually of corrugated iron, but plaited bamboo often finds a place in them either for making compartments or for making flooring.

"Under present conditions, when the distribution of rice from assembling to the terminal markets or centres of consumption is mainly financed by wholesale merchants or commission agents, the Indian rice grower is a loser to the extent of Rs. 200,000,000 annually at a conservative estimate. Much of this vast sum could be returned to him by a proper system of financing and by a more direct participation in the marketing process by the grower himself," says the Report.

Rice products.—The three principal rice products of commercial importance in India are parched riae (*Murmura*), beaten rice (*Chura*) and parched paddy (*Kheel*). On an average approximately 1,500,000 tons of paddy equivalent to about 1,000,000 tons of rice and an additional 35,000 tons of parboiled rice are estimated to be converted into these products every year.

Bengal is the largest producer of the parched products, altogether some 674,000 tons of rice or 8 per cent of the average crop of the province being used for this purpose. This quantity is considered to represent nearly 80 per cent of the total quantity of rice converted into parched products in India. Next to Bengal, the industry is of importance in the United Provinces while ranking third are the Provinces of Bihar and Orissa.

In Burma, about 20,000 tons of rice are manufactured into "Hmon-Hinga," a vermicilli-like preparation and a similar quantity is used for making various kinds of Burmese cakes.—(*Indian Information, Jan. 1942*)

SILK PRODUCTION AT HOME

To the millions of the poorer folks in the rural areas the rearing of the Eri silk worm offers a promising opening as a cottage industry with the pleasures of a spare-time hobby coupled with a profitable remuneration. The interest it offers and the returns it brings to augment the feeble earnings of the villagers in these days of low wages and unemployment, and the conditions of war in the silk producing countries in the East will certainly give all the incentive for the rearing of the Eri silk worm as a cottage industry. A brief outline ofthe methods of rearing the worm for producing silk is below.

As a cottage industry the cultivation of Eri silk worm and the production of the Eri silk is an ideal one. For, unlike the Mulbery silk worm the Eri silk worm feeds on the leaves of the castor plant, which is grown extensively in several places all over the country.

This silk worm need not be 'stifled' or killed as is the case with the Mulbery silk worm for taking out the silk, as the silk can be carded and spun even after the moth is allowed to emerge out of the cocoon, a point which will be appreciated by the orthodox people of any religion who are averse to killing. The Eri silk worm can be reared even in warm humid places where the Mulberry silk worm can be reared only with difficulty. Where the castor is grown on a large area for the sake of the oil seeds, this industry will form a side line by means of which the enormous amount of castor leaves which would otherwise go to waste, may be utilised for something better and profitable.

The Eri silk worm (*Attacus ricini B.)* got its name from its food plant Castor, which in Assamese language is known as 'eri.' The silk is also known as 'Assam silk.' It is a native of the lower south-eastern Himalayan regions and the rearing of the worm till late was confined to Assam.

The worm or the caterpillar is the young one of the moth belonging to the family of Saturnidae in the order of Lenidopetera, in which some of the largest known moths are found. The moth is fairly large in size with a wing expanse of about 4 to 5 inches. The colour is pale brown with whitish bands on the abdomen. The wings are pale white with olive bands and patterns over the ground colour. The moth generally does not fly but only flutters its wings and on that account there is no fear of their disappearing in captivity. The moth has no mouth parts and hence does not feed. The female is bigger and stouter than the male, but the male has pronounced feelers. The female moth lays eggs and these hatch out into worms which feed on castor leaves, grow in size, stop feeding, spin silken cocoons and pupate inside, from which after a time, the full grown moth emerges out.

Life history of the moth.—The female moth, after fertilisation, by the male, lays 100 to 200 eggs in clusters of one or more. The egg is small, oval and of greenish yellow colour. The egg hatches in about 10 days time and the worm appears which feeds on the castor leaves and grows big in size. After 3 or 4 days, it stops feeding and remains inactive for a day or two. And during this time it 'moults' or casts its old skin and emerges with a new one. It again feeds and moults at intervals of 3 or 4 days. It moults four times, everytime growing bigger and thicker. After the 4th moult, it feeds voraciously for a week or more and, when full fed, spins its cocoon. The full fed worm wanders away from food and seeks crevices or corners which offer facility for spinning the cocoon. In about two or three days, the worm completes its cocoon and pupates inside. The cocoon, pale yellow in colour, is elongate oval and measures an inch to an inch and a half from end to end. The full grown moth emerges out in about a fortnight to a month's time and mates immediately. The life of the adult is about 4 to 5 days.

So to get a crop of cocoons it may take anywhere from a month to two or three. Modest beginning, a thorough knowledge of the rearing of the worms, and the arrangements required for the same will go a long way to success. Things required for starting rearing:

1. Regular supply of castor leaves for food.
2. A place for housing the worms.
3. Rearing appliances.

A regular food supply is very necessary for rearing the worms. At least two months before starting rearing, castor must be grown in the bunds of fields or the back-yard of houses according to the quantity of worms one proposes to rear. To know how much of castor must be grown to rear a certain number of worms, the figures of Braine will be of some use. He says a third of an acre of castor will be sufficient to raise five broods of 8,000 worms each in a year. In the beginning it is advisable to grow a few cents of castor and rear some hundreds of worms, before one plunges into it on a large scale.

How to rear.—When the worms are reared on a small scale no special houses are necessary, as any well-ventilated room with a good flooring and clean walls is quite sufficient, but when rearing on a large scale is done a special thatched shed may be erected.

Some bamboo trays, (for keeping the eggs and the worms) and some bamboo baskets (for keeping the worms at the time of spinning the cocoons, and for storing castor leaves) are necessary. Bamboo trays of rectangular shape, 3 feet long and 2 feet broad and 2 inches deep are ideal. A tray of this size will hold about 400 worms when full grown. A rack for keeping these trays may also be made of bamboos. When the trays are kept in the rack in rows there must be a space of about 9 to 12 inches between rows. The legs of the rack may be kept on small pans containing water. This will prevent ants and other vermin troubling the worms.

The best season for starting rearing is just after the heat of the summer is over. The months of July and August are ideal. It is better to get "seeds" (eggs) than cocoons to start rearing the worms, for if cocoons are got, there is a danger of introducing a fly parasite also along with them. Disease-free eggs may be obtained from the Sericultural Expert, Kollegal or Government Sericultural Farm, Coonoor. The eggs, as soon as received should be kept in trays in a cool airy place and if the days are very hot a wet cloth may be used to cover the tray. When about to hatch, the eggs turn gray in colour and at this time tender castor leaves must be spread over them so as to enable the young worms to feed on the leaves when they emerge out of the eggs. Eggs of different days should be kept separately. Some hours after the worms come out of the eggs the leaves with the worms clinging to them must be removed to fresh trays with tender leaves.

Feeding routine.—The young worms must be fed with tender leaves both in the morning and in the evening. In dry hot weather it may be increased to three times. The worms 'moult' or change its coat several times before they build their cocoons and pupate. Just before each moult the worms are sluggish and do not feed and at these times feeding may be suspended. After each moult the number of times of feeding may be increased by one, starting with two times as the basic feeding and after the fourth moult when the worms feed voaciously they should be fed five or six times during the day and once or twice at night. Care should be taken that the leaves are fresh and free from dust. Wet leaves are injurious to the worms as they are responsible for certain diseases which kill worms in numbers. Tender leaves for the young worms and mature leaves for the older worms may given as a rule. When the worms stop feeding and wander away from the leaves they may be put in baskets for spinning cocoons.

The worms require healthy and sanitary surroundings. They should be housed in well ventilated houses and proper care must be taken to the feeding and handling. When the weather is hot and dry the rooms where the worms are kept can be made cool and moist by sprinkling water on the floor now and then. As the worms grow in size they may be distributed to other trays so as to provide them with more space. When changing the leaves the worms should be lifted only with leaves to which they cling and on no account should they be touched by hand. The litter and any dead worm must be removed far away from the rearing house and stored well as they have a high manurial value.

Economics of silk production.—According to an authority who conducted certain experiments on this aspect of the question the following information is available. In all these industries the profit and loss cannot be said with arithmetical accuracy, as the factors involved in such calculations are very variable. But mostly they are dependent upon the quality of the cocoons and the fluctuations of the market. To get a pound of silk yarn about 4,000 healthy worms are required including all losses during the production. A small family of three persons may rear conveniently about 8,000 worms in a brood, and in a year 5 or 6 broods may be raised. This will mean about 40,000 worms yielding about 10 maunds of silk yarn. This would fetch about rupees 35 to 40. This is the profit for the year for their spare time work, provided the whole of the work was done by the members of the family and not by paid labour. The intial cost for the appliances etc., will come to about Rs. 12 to 15. The food material of course must be grown in the back-yards or on the bunds of the field for oil seed purposes and nothing need be spent on that account. The profits at the present time may be even better than those noted above. But anyway for a small family earning about ten rupees a month on an average, a sum of 5 or 6 rupees extra income from this source will certainly be very welcome, as the work involved is not very heavy.

Having understood the methods of production of cocoons it is necessary to see that they are easily sold. When a number of people in a village take to this as a cottage industry the crop of cocoons may be brought to a silk Cocoon Co-operative Sales Society, formed on account of this and thus the product marketed easily to big purchasing firms in and out of India.

This is the right moment to start this industry in India, since supplies of silk from overseas have been diminished or practically cut off. It is not possible to produce Mulberry silk everywhere as the worms are too delicate and require special skill in rearing, whereas, the production of Eri silk is not quite so difficult. It may be considered part of the agricultural industry if cocoons may be taken as the fruits of the castor. In this direction. it is hoped that the Government will kindly give all the impetus and help necessary to eatablish this as an industry in every cottage. (*"The Hiudu"*)

ACTIVATED COMPOST

The problem of manure is a widely felt one in India, but unfortunately a correct appreciation of the importance of scientific manuring is lacking even among the educated rural uplifters. It is true that superphosphates, nitrates and other chemical fertilisers are at large in the market, but their cost is prohibitive enough where large scale cultivation on an economic basis is practised. Thus the importance of manure that could be cheaply produced from easily accessible waste products. In this connection the remark made by Sir Wm. Crookes at the meeting of the British Association in 1898 may be noted: "It is through the laboratory that starvation may ultimately be turned into plenty."

Ordinary compost is made by stacking leaves and kitchen refuse in pits, and allowing them to crumble down by bacterial infection. It usually takes six months for a heap to come to the suitable state. This compost, which is grey in colour and mcderately rich in phosphates, potash and nitrogen (the three essential plant foods), has the chief disadvantage that it takes a long time to be ready for use. And if it is used before complete disintegration, the grubs and insects present do harm to the plants manured with it. Hence the need for accelerating the disintegration.

This can easily be done by sprinkling a thin solution of raw cowdung on the leaves and other refuse. In practice it is done as follows: Three or four pits each six feet long by three feet broad by three feet deep, are dug near to each other. Having secured the rubbish needed, a layer of it is put in the first pit and the weak cowdung solution sprinkled over it. Another layer of refuse, six inches or so deep is again put followed by the solution. It is always better to finish off with the rubbish. Now the whole thing is stacked as closely as possible with poles. The pit should be completely covered with the refuse and matter can rise above it as a heap. No space should be left between the top of the pit and the rubbish heap, or rain water would go in and spoil the process. After a week, the temperature of the heap will go far above that of the surroundings (70 degrees C has been reported) After two months the compost is ready for use; in the final state it would crumble if taken between the fingers. A weekly stirring up and restacking will ensure a uniform composition.

Use of permanganate of potash.—Activated compost thus prepared is rich in nitrogen, from the cowdung, and there is no need to add any nitrogenous chemical. But a slight amount of potash chloride (¼ oz. per gallon of water) may be slightly sprinkled along with the dung solution. Phosphate is not needed, as the dung contains enough of it for ordinary consumption. Mr. Fowler, in an article in Pocha's "Garden Guide" suggests the use of a dilute solution of permanganate of potash as an accelerator, instead of cowdung, and the process is reported to be speedier by this method (¼ oz. of permanganate to 2 gallons of water is suggested). I have experimented with the chemical and found that its action is speedier: and on adding a very dilute solution of hydrochloric acid (10 oz. of .05 normal acid—i. e. acid that is just sour—per one gallon of the permanganate solution), I find that the action is very much accelerated. (This method was suggested by the well-known chemical fact that acidified permanganate is much more active as an oxidizer than the normal chemical). There need be no fear that the compost will turn acidic by this process, as the acid is converted into potash and manganese chlorides in disintegration. In actual experiment it was found that even a higher strength of acid could be used, and it has also the advantage that it keeps down insects. But above a certain strength, it may cut down the essential bacterial process itself. The permanganate process, if done with the aid of acid takes only three weeks. But the price of the chemical is rather high, and as cowdung is easily available, the permanganate method need be tried only on a limited scale.

The other pits made by the side of the first pit could be stacked with rubbish and could be activated by mixing with it a quarter of the substance of the first pit. (This should be done when the first pit is about two weeks old and is warm with the disintegration). Thus all the three or four pits could be used, fresh rubbish being added to the first pit and the finished compost being removed from the last one. Thus a continuous supply of compost is available. The second and third pits also need the cowdung solution, but to a lesser extent, as the disintegration is already started by the portion of the active compost from the first pit. The third pit could be injected with matter from the second pit and so on.

Compost thus produced, if reinforced with a slight amount of potash chloride as suggested, is the best manure possible for tomatoes, brinjals and other vegetables, and as the materials needed are cheap, will repay the trouble of a trial.—*(The Hindu)*

DRIED MILK—ITS STORAGE AND USE

Dried milk has been recommended by nutritional experts as a valuable food item for the ill-fed population of India. In many towns and villages, the supply of cows' or buffaloes' milk is barely sufficient and this highly valuable food drink is never even tasted by millions of the poorer classes. Powdered milk has become an important war-time food in England and the following instructions regarding its storage and use issued by the British Ministry of food may be of value to many people in India also.

The British Ministry of Food, it was reported, has arranged for School canteens, residential schools, and hostels for children to obtain supplies of dried separated milk. This milk is an excellent food, one ounce of powder being equivalent in most respects, except fat content, to about ½ pint of liquid milk. It is particularly valuable as a supplement to the allowance of meat and cheese, says a note in Education, and is primarily intended for use in cooking, e. g. for milk puddings, custards etc., and as an addition to soups, stews and gravies. The low price of this powder makes it a very economical source of protein, and schools and hostels are strongly recommended to take advantage of this scheme.

Storage and use.—The supplies of dried separated milk are of two types: (a) Spray process milk powder and (b) roller process milk powder. The powders will keep satisfactorily for several months if stored in a cool dry place away from strong-smelling food stuffs.

The following instructions regarding the storage and use of dried separated milk powder has been issued:

In colour the two types, roller process milk powder and spray process milk powder are similar, being a pale cream; but in texture the roller powder is coarse and flaky, resembling ground rice and spray powder is fine resembling cornflour.

The milk powder will keep satisfactorily for several months if stored in a cool dry place away from strong smelling food-stuffs. It is not necessarily unfit for use if it becomes caked but must not be used when musty. The milk powder should be stored in the container in which it is delivered until required.

Uses of milk powder.—The powder is primarily intended for use in cooking. It is highly nutritious food and may be added to pastries, puddlings, stews and soups. It is important because of the texture of the spray process powder that care should be taken in adding liquids to it and the directions given below must be carefully carried out to obtain a mixture free from lumps. If both powders are available it is preferable to use the spray process powder dry, i. e. added to flour, and to use the roller process powder for turning into separated milk (at the natural strength or stronger).

(a) **To use in liquid form.**—Turn the powder into milk (see the mixing directions) and use in the same way as ordinary milk for custards, sauces, blanc manges and milk puddings of all types. Add in milk form (or stronger) to stews, soups (the milk should be added to stews and soups before they are thickened), minces, flaked fish for fish puddings, fish cakes and other savoury dishes. Also use in mashing potatoes or other vegetables.

(b) **To use in powder form.**—The powder may be added to flour for pastry and pudding mixtures. Roller process powder can be sprinkled into lukewarm stews and soups before thickening and both powders are suitable for mixing in powder form with mince flacked fish, potatoes and other vegetables. Up to ½ lb. of milk powder may be added to 1 lb. mince or flaked fish or potatoes and the same quantity may be used in 1 gallon of soup or stew. Roller process powder is also appetising served sprinkled on stewed fruit.

Mixing Directions

Spray process separated milk powder.—Place the required quantity of lukewarm water into a vessel. Measure out the quantity of powder required; place part of the powder on top of the water. Whisk briskly with a fork or whisk gradually adding remainder of the powder, making sure that it is thoroughly dissolved in the water. The use of lukewarm water will give a quicker solution, but cold water may be used.

Roller process separated milk powder.—Place the required quantity of powder into a vessel, cover with hot water (not boiling) mix into a smooth paste with a fork or whisk gradually breaking up all lumps. Add the remainder of the water required, stirring briskly until thoroughly dissolved.

Quantity required.—(i) When cooking with small quantities it is convenient to take 3 heaped tablespoonfuls of the powder as roughly equal to 2 ozs. of powder, which will make one pint of separated milk at natural strength.

(ii) For larger quantities the powder should be weighed out and the following mixing table is recommended:—

To make separated milk at natural strength

Quantity of separated milk required	*Ounces of milk powder necessary*	*Pints of water*
8 pints (1 gallon)	16	8
6 "	12	6
4 "	8	4
2 "	4	2
1 "	2	1
½ "	1	½

Lukewarm water or cold water when using spray process separated milk powder. Hot water (not boiling) when using roller separated milk powder.—(" *The Hindu*).

CARING FOR THE VITAMINS

The following hints are from " America's Nutrition Primer " by Eleanora Sense of the New York State Dietetic Association.—Don't peel vegetables and leave them standing in water before cooking. Removal of the natural protective cover permits loss of vitamins and minerals, and this process is hastened when the foods are immersed in water, which dissolves the food factors. To minimize dissolving, vegetables should be cooked whole, peels and all, as quickly as possible, and in small amounts of water. Whatever liquid is left should be served with the dish or utilised in soups or sauces.

Since vitamins are lost less rapidly when water is acid, vinegar or lemon juice added to cooking vegetables will ensure preservation of a large proportion of the health-promoting substances. Contrary to common belief, soda doesn't improve the quality or flavour of vegetables and, being alkaline, actually helps destroy vitamins.

The widespread practice of dropping two eggs "sunny side up" on a sizzling pan is nutritionally criminal. Since rapid heating causes proteins in egg white to coagulate into a relatively indigestible form, the correct method is to do the frying on a warm but not too hot skillet.—(" *The Hindu.*")

College and Hostel Notes

The Students' Gathering is the most festive annual event of this College. The various events connected with the Gathering, were held from 28th November to 1st December. This year we consider ourselves fortunate in having secured the gracious presence of our distinguished guest of honour, the Hon'ble Mr. Brijlal Biyani, Member of the Council of State and the President of the Vidarbha Congress Committee. He very kindly accepted our invitation to address us and give away the prizes. We are extremely grateful to him for sparing his precious time for us inspite of his multifarious engagements. Mr. Biyani's interest in Agriculture, and his persistent efforts in the amelioration of the suffering of the agricultural classes are facts too well-known.

His address was highly illuminating. The summary of his speech is published in this issue under the editorial.

Sports, visitors' debate, variety entertainment of classical and oriental dances by Mr. R. N. Mandoli with orchestral accompaniments of Chhatrasamaj Mandal, and Fancy Dress competition were the important events of the celebration.

Sports formed almost the integral part of the whole programme. Play grounds were buzzing with great activity throughout the week. Inter-class hockey, football and volleyball matches evoked a great healthy rivalry among the different classes. The final match in the tennis tournament (singles) was played between the veterans Messrs B. B. Banerjee and Ajit Singh of the IV year. Mr. B. B. Banerjee won the match. Another tennis match (doubles) which was played between the staff and students, created a great interest. Messrs N. M. Joglekar and R. L. Gupta represented the Staff. The other events in which the members of the Staff took part were:—Tug of War, Cricket match, Relay race and Cock fight. All these events were particularly interesting to all, and very encouraging to students.

With the help of Mr. K. R. Sontakey, a visitors' debate was arranged in the College Hall on the 28th November at 8 p. m. The debate lasted for two hours and the audience had an intellectual feast. The resolution discussed was as follows:—"In the opinion of this house, greater service to humanity is rendered by those who grow two blades of grass in place of one than all the politicians put together."

Opening the proceedings, the President Mr. Churchill, Principal of the College said "It is with a sentimental sense of joy and pride that I have to accord a hearty welcome to the speakers. I request the speakers to take their seats on the dais."

The following spoke for the resolution :—

1. Mr. Abdul Razak Khan, B.A., LL.B. 2. Mr. J. P. Gimi, B.A., F.R.M.S., 3. Mr. K. R. Sontakey, M. SC.,

The following spoke against the resolution :—

1. Mr. C. B Parakh, B.A., LL.B., 2. Mr. George Jacob, M.A ,
3. Mr. R. B. Maolankar, M.A.

With the permission of the President Mr. S. K. Mishra spoke for the resolution and Mr. N. G. Hande, a student, against it.

The resolution was put to vote and was carried. The honourable visitors were thanked by the General Secretary and the meeting was declared closed.

On the 1st December at 5 p.m. the photograph of late Mr. S. B. Gokhale, Advocate, Nagpur was unveiled by Hon'ble Mr. Brijlal Biyani just before he delivered his address and gave away the prizes. The prize giving ceremony was followed by the most pleasant function i. e. dinner in Indian Style. This was really unique in this respect. Thanks are due to the following staff members of the managing committee. E. A. H. Churchill Esq., Dr. V. G. Vaidya, Hostel Wardens—Messrs S. K Misra and K. S. S. Iyer and Mr. M. A. Rahim.

We shall be failing in our duty if we do not express our great appreciation of the work of various office bearers and the volunteers who laboured night and day to make the College Day Celebration a success.

PRIZE WINNERS IN SPORTS

	First	*Second*
Three mile race	...Mr. K. Kaushal	Mr. N. K. Mahranwar
One mile race	... ,, K. Kaushal	,, R. S. Raghuwanshi
440 yards	... ,, N. K. Mahranwar	,, B. P. Misra
220 ,,	... ,, N. K. Mahranwar	,, G. T. Soaji
100 ,,	... ,, G. T. Saoji	,, N. K. Mahranwar
Bullock race	... ,, C. L. Arzare	,, S. K. Palnetkar
Sack race	... ,, S. K. Palnetkar	,, G. T. Saoji
Long jump	... ,, G. D. Dubey	,, C. S. Iyer
High jump	... ,, H L. Patel	,, G. T. Saoji
Putting the shot	... ,, C. S. S. Mudaliar	,, Trilochansingh
Cock fight (Students)	... ,, G. T. Saoji	
Tug of war (Students *Vs.* Staff)	... ,, Staff (winners)	
Cock fight (Staff)	... ,, G. R. Tatwawadi	
Relay race (Staff)	... ,, Entomology Section	
Swimming competition (100 yards)	... ,, V. B. Rasal	,, R. S. Maholey
Swimming competition (220 yards)	... ,, V. B. Rasal	,, V. P. Chiddarwar (Extra Prize R. S. Maholey)
Inter Class Football	... II year (winners)	
,, Hockey	... IV year ,,	
,, Volley ball	... III year ,,	
Volley ball (Doubles)	... ,, J. P. Nayak and	,, L. P. Nayak (winners)
	Winner	*Runner up*
Tennis Singles	... ,, B. B. Banerjee	,, Ajit Singh
Doubles (Staff *Vs. Students*)	... ,, B. B. Banerjee & ,, Ajit Singh	,, N. M. Joglekar and ,, R. L. Gupta

Indoor Games Ping Pong...	,, B. B. Banerjee	,, P. S. Pimpalgaonkar
Carrom (Singles) ...	,, G. L. Chandrawanshi	Mr. B. B. Banerjee
,, (Doubles)	,, Khandalwar & ,, Khautate	,, Banerjee & Mr. Ajit Singh
All Round Sportsmanship...	,, N. K. Mahranwar	

OTHER EVENTS

Variety Entertainment ... Mr. R. N. Mandloi
Fancy Dress Competition ... ,, R. C. Jain
... ,, N. H. Sohni
Special prize by P. M. Ingley ... ,, N. K. Yerawar

Elocution competition
English ... Mr. D. N. Kherdekar & Mr. G. N. Hande
Marathi ... ,, S. D. Deshmukh
Hindi ... ,, R. B. Mandloi

First Prize (Mr. R. N. Dube's Prize) for best Milk-man Mr. B. C. Jain
Second ,, (,, S. K. Misra's ,,) for best Milk-man ,, C. L. Arzare

PRIZE WINNERS (ACADEMIC) 1940-41

Name of the Prizes	*Subject in which awarded*	*To whom awarded*
	Final Year	
Symthies Chemical Medal	... Chemistry	Mr. K. P. Lele ,, M. J. Khare ,, S. L. Shrivastava
Kedarnath Rai Prize	... Agricultural Engineering	,, S. L. Patni ,, K. S. Krishna Rao
The Napier Essay Prize	... Essay	,, V. V. Gokhale
Special Prize	... Agriculture	,, K. S. Krishna Rao
Special Prize	... Entomology	,, R. P. Jyotishi
,,	... Botany	,, B. C. Pradhan
,,	... Veterinary	,, B. C. Pradhan
	Third Year	
Kalidas Choudhari Medal	... Practical Agriculture	,, Jagannath Hota
Phatak's Prize (private)	... Agriculture	,, Jagannath Hota
Class Prize	... Best all round student	,, Jagannath Hota
	Second Year	
Coronation Commemoration Prize	... Best all round student	,, P. S. Parsai
Chakradeo Prize (private)	... Practical Agriculture	,, P. S. Parsai
Class Prize	... Mathematics & Survey	,, P. S. Parsai
,,	... Elementary Science	,, P. S. Parsai
,,	... Agriculture	,, P. S. Parsai
	First Year	
Special Prize	... Best all round student	,, A. C. Jain
Class Prize	... General agriculture	,, A. C. Jain
,,	... Practical agriculture	,, A. C. Jain
,,	... Mathematics & Survey	,, A. C. Jain

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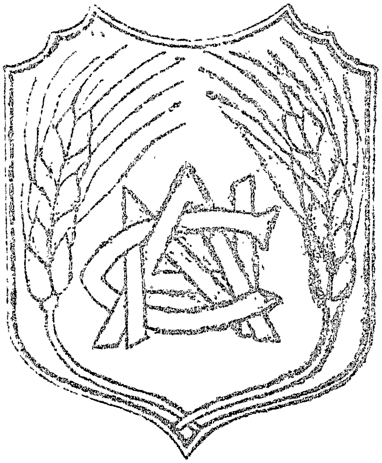

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Editorial

GROW MORE FOOD

Manufacturing industries have shown a remarkable adaptability during the war. It is reported from England that firms engaged in manufacturing teapots are now engaged in manufacturing tin hats, and cap factories are turning out bullets. If specialized industries have thus managed to swing over to the production of articles needed for the prosecution of war, it is in the fitness of things that agriculture also follows suit and does its best in achieving the common purpose. Every agriculturist has now to discard his traditional method of crop-planning and has to address himself to the task of producing whatever is really needed at the time. From a commercial point of view growing for the international market is for the present a matter of history. The normal routes of trade are no more open as in peace-time and the shortage of shipping space for non-essential purposes is evident. The disappearance of these usual facilities have an immediate effect on the market, which is exhibited by a fall in the prices of such goods and by a glut of unexportable commodities. Hence, there is no benefit in growing such crops at a time when their disposal is very problematic. On the other hand, the dislocation of trade has affected the import of foodstuffs like wheat from Australia and the Burmese rice. The supply of these commodities has now to be made up in India. It is thus apparent that attention must be concentrated on growing food crops and the production of non-food crops should be reduced.

Apart from this commercial point of view, a drive towards more food production is necessary in order to keep the general population supplied with usual requirements. Shortage of food causes suffering and leads to disturbance, thus endangering peace and satisfaction, so needed to keep up the country's morale. To the fighting forces a regular stream of food supplies has to be maintained. It is here that the agriculturist can offer his mite and help those who are fighting for him.

The changes which may be introduced in the light of the circumstances outlined above, may now be referred to with particular reference to the Central Provinces and Berar. The Provincial Government has already given much publicity to this by issuing special instructions to the cultivators of the three different tracts in the Province. The cultivators of the Cotton tract have been advised that the area under Cotton should be restricted and the cultivation of short staple cotton should be abandoned. It is feared that there will be a further lowering of prices of short staple cotton to a point at which it would not cover even the cost of cultivation. It is even possible that it may become practically unsaleable. There is already a surplus estimated to be 2 to 2½ lakhs of bales which will have a very depressing effect on the market. The cotton areas thus released may be taken up under the kharif crops, juar, bajra, tur and groundnut and by rabi crops i. e. wheat and gram. Production of juar has to be stressed as it can replace cotton most easily. Bajra is expected to do better on light soils. Groundnut will have an easy sale as the provincial consumption exceeds present production. Mung and Urid would make a valuable addition to pulses. These may be sown in lines alternating with juar or in mixture with juar. With regard to rabi crops, wheat and gram may be sown in low lying heavy soils where the crop will be more secure than cotton.

The cultivators of the wheat tract have been strongly advised to grow as much of wheat as possible. Where Deshi and medium staple used to be grown, it has been pointed out, that juar, wheat and gram would do well. In the Hoshangabad District, in some parts of Saugor, the plateau of the Chhindwara and Betul districts cotton should altogether be discarded. The demand for linseed having fallen, there is no benefit in growing it on the same scale now. The area under Kharif Juar may be increased. In the Haveli tract, fields may be double cropped with paddy and gram. Field embankments should be kept in proper repairs for the collection of maximum water which would ensure a good rabi crop. Upon the cultivators of the rice tract lies the great responsibility of augmenting the supplies of rice which have been reduced to a very low level owing to low outturns for the past three years. Though the need for wheat is equally great yet the rice tract should concentrate mainly on rice. Rabi area should be diverted to paddy. Paddy when followed by Utera would give greater profit. In lands sown with rabi, first preference should be given to wheat and the second choice should be gram and the pulse crops. In the heavy-soil tracts high lying level areas may be bunded. This would make them suitable for rabi crops and would also provide irrigation to paddy fields lying in the lower areas. Juar and Bajra would make a useful addition. In the meantime, special efforts should be made to increase the outturn of paddy by increasing the manure supply. The preparation of bone manure, and the preparation of compost with all available vegetable waste matter is strongly recommended. In all the tracts special attention should be paid on growing vegetables.

The special facilities made available by the Provincial Government in order to encourage the growing of food crops may also be noted. The principal inducement is offered to the growers in the districts of Amraoti, Akola, Yeotmal, Buldana, Nagpur, Wardha, Chanda, Chhindwara, Hoshangabad and Nimar for diverting the area under cotton to food grains. They would get a subsidy of Rs. 2/- per acre for such areas. The total payment is limited to Rs. 20 lakhs. If the amount claimable exceeds this total a pro-rata division would be made. In the rice growing areas, special permission has now been granted for removing silt from the irrigation tanks, for being used as a fertilizer on fields. Arrangements are also made for granting leases of unoccupied Government lands outside reserved forests. The leases would be free of rent and would be given temporarily on the condition that such land is to be used for growing food crops only.

It is feared in certain quarters that an intensive effort in producing more food grains might bring down the prices and would cause great suffering, specially on the termination of hostilities. These doubts may be set at rest by pointing out that such a sudden fall is not likely to take place. Even if such a contingency arises it has been declared that the Government would immediately buy such quantities in the open market as are calculated to prevent a further deterioration in prices.

Original Articles

CULTIVATION OF JUAR AS A FODDER AND SILAGE CROP ON THE COLLEGE FARM, NAGPUR

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Introduction.—The subject of fodder crops for feeding the live-stock on a farm is growing rapidly in importance in Indian Agriculture particularly during recent years, but the growing of a crop solely for the sake of its fodder value alone is almost a new thing to the cultivators in these provinces. Although a large amount of fodder for the farm animals has, as a matter of course, always been obtained by the growing of such crops, as juar etc., yet these have invariably been obtained, so to say, as a by-product of juar and other crops, grown mainly for grain purposes. The growing of special crops, solely for fodder, is due primarily to the general increase in our knowledge of what constitutes a good nutritive feed, both for man and beast. Besides this, the increased demand for larger quantities of milk for supplying growing towns and large cities, necessitates the conduct of experiments for increasing the milk supply of cattle and the raising of succulent food by the cultivators engaged in its production. In addition to this, it is being gradually recognised that if an animal is expected to work, or to produce milk, better and more substantial food should be provided than can be picked up by the animals themselves during the greater part of the year, by wandering over the bare fields, scattered waste land, bunds and stony hills, as is usually the case, or that furnished by rice or wheat straw or a limited quantity of Juar kadbi. Hence, the provision of adequate and proper nourishment is the foundation on which the health and capacity of working animals or milch cows really depends. Pasture which is the natural food of cattle is not available all the year round, owing to climatic, economic and other reasons. On account of the pressure on the land caused by the ever increasing human population, even the waste lands are being steadily brought under cultivation. In spite of 215 million heads of cattle in India, the area purely under fodder cultivation, is estimated to be 9.26 million acres, which is extremely insufficient for the purpose. This area, when compared with that under other crops for man's necessities, amounts to only about 5% of the total cultivated area in India, although the proportion of human population to that of cattle is roughly 100:80. Over a considerable part of India the only food supplied to the animals consists of the stalk or straw of the grain crops such as rice, wheat, juar or millets, etc. along with such scanty grazing as is available. In some of the provinces, however, fodder crops for fodder purposes only are grown to a certain extent, especially in the Punjab, Bombay and U. P. The area under these however is only 0.46 million acres in C. P. and Berar, out of a total of 27.5 million acres actually under cultivation.

Main features of a good fodder crop.—If a crop is to be of value to a farmer as a special fodder crop for which he intends to devote a considerable portion of his land, it must possess the following characteristics:

(1) The crop should be palatable, digestible and not injurious to the animals. It should contain less fibre at the time of harvest, either for silage or hay.

(2) The crop chosen should be a heavy yielder so as to get the biggest return for money spent on seed and cultivation, and should not require much manure.

(3) A successful crop must be one which is of short duration, so that the land can be used for other crops.

(4) The crop grown should require less cultivation, manuring and care, even though good fodder as a rule needs a fairly high tillage and manuring.

(5) A good fodder crop should have the capacity of being preserved without much loss, either when dried as straw or hay, or when semi-fresh as silage.

Importance of fodders.—The most important function of a fodder is to provide bulk to a ration. All animals require a large bulk in their rations; fodders therefore must necessarily be fed to cattle, if they are to be in good health and be able to do work or to provide a supply of milk. Besides this, it has a special importance to milking cows and young growing stock in providing milk and feeding the unborn calf as well. It is especially essential to young stock, not only for the valuable nutrients it contains but also for its vitamin contents which are essential for growth and development.

Fodder crops of the Central Provinces.—There are a large number of crops used for fodder in these provinces due to the variability of its soils and climatic conditions in different parts. We have soils varying from the heaviest black clay, to light sandy loam, with a large range of intermediate types. Besides this, the amount of rainfall or water supply is also different for different tracts, so that we have well defined climatological zones.

The main fodder crops can be classified as follows :—

(i) Cultivated cereal fodder crops,—Juar, Maize, Bajra.
(ii) Natural fodders, i. e. indigenous and exotic grasses.
(iii) Cultivated leguminous crops,—clover, Lucern, etc.

Juar.—Of all the plants grown in the world for the production of fodder, Juar probably stands first in being capable under a great variety of conditions, of producing a very large quantity of palatable fodder in the minimum of time and fairly dry conditions. It is a tropical or semitropical plant and its varieties are grown all over such regions of the world. In India it is very highly prized as a general fodder crop because it can be grown successfully over a wide area and is capable of producing a large yield of nutritive substance, highly digestible, very palatable and relished by all live-stock. It serves as an excellent green fodder for cattle. Its varieties can be so arranged to be grown as to provide succulent food throughout the major portion of the year. It is the best crop for furnishing succulent fodder during summer or during the early part of the rainy season in the form of silage. It also serves as an excellent source of both dried roughage and of concentrates, when ripened and handled in the usual way. A crop of juar is generally unaffected by the dry atmospheric conditions usually prevailing in this province even when it is grown on loamy soils. It requires less water per pound of dry matter produced when compared with other cereals except maize. The water requirements for the different cereals as found by Leather (1910) at Pusa is given below :—

Wheat	554	lbs.
Oats	469	„
Barley	468	„
Maize	337	„
Juar	437	„

General characteristics of Juar.—The number of varieties in general cultivation throughout India is very large. These are divided into two groups. (1) The Kharif Juars which are grown during the rainy season. (2) The Rabi Juars which are grown during the cold season. A rabi variety does not thrive well if sown as a kharif crop as it does not require a high temperature or so much moisture. Similarly the rainy season varieties, as a rule, do not thrive well if sown in the cold weather due to low atmospheric temperature and lower moisture content of the soil during its growing period.

Development.—The development of the plant as regards its length and thickness of its stalk, size and weight of grain head, etc. depends more upon the character of the season, the kind and the condition of the soil, the quality of manure and fertilizers applied, the method of cultivation etc., than upon the actual differences between varieties.

Thick and thin sowing.—If the seed of any variety is sown thickly in a good well manured soil in a favourable season the stalk will grow tall and thin and produce small heads of grain. It cannot therefore be said that any variety grows to a particular height and produces heads of grain of a particular weight and size.

Tillering.—None of the varieties examined has any decided tendency to produce more than one shoot from one root. Numerous shoots, coming apparently from one root indicate a check in the main stem in the early stages of its growth or diseased condition, whereby the growth of the main shoot is stopped and the number of side shoots spring out to continue the life of the plant. In some varieties a much more vigorous growth springs out from the stubble of a reaped crop than in others.

Head of grain.—Generally each single stalk produces one head of grain but in some varieties the principal stalks have side shoots each of which produces a cob which ripens later than that on the main stalk. The usual weight of heads ranges from 2 oz. to about a pound or so.

The fodder.—The fodder of some varieties when ripe is more nutritious than that of others. There is hardly any other crop that can equal juar in this respect. It is grown at different periods so as to supply green fodder throughout the year provided that irrigation facilities are available

Hence there is no reason for the introduction of any other plant of the same group, for making silage.

The chief reasons in favour of this are :—

(1) It is adapted to a wide range of soils, and gives the largest yield of digestible dry matter per acre of any crop that is now grown.

(2) In its immature state it is highly palatable.

(3) Ordinarily it is one of the least expensive crops to grow and is superior in contents of the total dry digestible matter to other fodder crops grown under similar conditions.

(4) It is completely utilized, either as a grain crop, hay or silage.

(5) It is the most satisfactory silage crop out of all the other crops grown in India.

(i). The main points for consideration in choosing the varieties are the time of its maturity, as the late varieties do not make as good green fodders as the early ones do (ii) the proportion of stem and leaves, the leaves being more nutritive than the stem. The high nutritive value possessed by the grains of sorghum and by green juar as fodder, compared with that of turnips which are greatly prized as fodder in England, will be evident from the following table :—

	Juar	Rice	Wheat
(a) Albuminoid ...	9.3%	7.3%	10.1%
Starch ...	72 3%	78.3%	68.4%
Oil ...	2.0%	0.6%	1.2%

	Green juar	Turnips
(b) Water ...	85.17%	90.43%
Albuminoids ...	2.55%	1.04%
Starch and fats ..	11.14%	7.89%
Ash ...	1.14%	0.64%

Several varieties of juar such as, Utawli, Sundia, Ramkel, Nilwa, Amber, Collier, Lambkansi, Ringni and Hundi were grown on the College Farm for a number of years with a view to finding out the most suitable one under the local soil and climatic conditions and it was found that Ramkel Juar was the best in this respect as it yielded the highest outturn of digestible matter per acre and at the same time it became ready at a time when it could be turned into silage economically. On the College Farm Juar is grown on some 52 acres annually for fodder purposes to be consumed either as hay or to be filled in the silo.

Season.—It is mainly sown as a kharif crop in the 3rd week of June in places where the rainfall is below 50" and where it is well distributed.

Rabi varieties such as Ringni, Salu are sown between September and October in the districts of Nagpur, Bhandara and Chanda.

Mixed cropping.—Various pulses, oilseeds and fibre crops are generally grown by the farmers with the kharif Juar when it is meant for grain. Whenever it is grown for fodder however either cowpea or cluster beans are sown with it.

Cultivation.—The preparation of seed bed in time is very important in growing fodder crops. After the removal of the previous year's crop during the month of November, the field is allowed to be grazed for a fortnight. It is then manured with 4 tons of Gutterfly (cotton waste) early in December. When the aim is to secure as large an yield of succulent food as possible, it is necessary that plants should have an abundant supply of plant food in the soil. This manured area is ploughed 5″ to 6″ deep, with a soil inverting plough in cold weather and allowed to remain untouched till the end of the hot weather. The manuring should be liberal and should be supplemented by fertilizers, as the millets belong to a group of crops that grow quickly and often reach a height of 10′ to 15′ in a short space of time. The maximum amount of crop can only be secured when all the plant food necessary is in abundance. In favourable season the crop will reach the cutting stage for silage in about 110 days after sowing. While all this is expensive, when a large area of 52 acres is being grown, nevertheless it is economical. Immediately after the break of the monsoon the land is bukhered twice so that a deep fine moist seed-bed is made ready by the 3rd week of June.

Rotation.—Juars are grown on morand soils and in rotation with cotton in two or a three course rotation of cotton and juar or of cotton, Cotton and Juar. Tur is always sown in lines as a subsidiary crop with cotton and juar in the proportion of one or two lines of tur with 10 or 11 lines of cotton or juar. On this farm the Kharif area is subdivided into 7 blocks for a seven course rotation of cotton, juar tur, sannhemp, wheat, gram and linseed, which are well adapted to the conditions of soil and climate of this Farm. Hence the seven course rotation is followed in sowing fodder juar. 1st year fodder, 2nd Year cotton, 3rd year fodder, 4th year Rabi legume, 5th year fodder, 6th year cotton, 7th year Kharif legume, (sann and tur). The cropping scheme on the College Farm will be quite clear from the following diagram.

Year	I	II	III	IV	V	VI	VII
1932—33	F	C	F	R	F	C	L
1933—34	L	F	C	F	R	F	C
1934—35	C	L	F	C	F	R	F

F=Fodder
L=Kharif legume
C=Cotton

1935—36	F	C	L	F	C	F	R	R=Rabi legume.
1936—37	R	F	C	L	F	C	F	
1937—38	F	R	F	C	L	F	C	
1938—39	C	F	R	F	C	L	F	

Manuring.—The following manures are used on this Farm.

Organic manure	Nitrogen	P_2O_5	K_2O	*Inorganic manure*	Nitrogen	P_2O_5
1. Farm yard manure	0.4%	0.21	0.5	1. Am. sulphate	20%	
2. Cotton waste gutterfly	1.0 to 1.5%			2. Sodium Nitrate	15.6%	
3. Compost	0.8 to 0.9%			3. Super-phosphate		16.18%
4. Urine earth	0.58%					

The organic manures are applied as a basal dressing as detailed below :

1. Farm Yard Manure	... 6	tons per	acre to the	cotton crop.
2. Gutterfly	... 4	„	„	Fodder crop.
3. Compost	... 3	„	„	Miscellaneous crop.
4. Urine earth	... 4	„	„	Cotton or Fodder crop.

Fertilizer.—For Cotton and Fodder juars 200 lbs. of super phosphate per acre before sowing used to be given and mixed with the soil by repeated bukhering. These are also top dressed with ammonium sulphate in July or early August at the rate of 80-100 lbs. per acre according to the condition of the crop at the time of application. Lowlying areas of cotton and juar, in case the growth of the crop is not satisfactory, are top dressed with nitrate of soda, late in July and middle of August, in two doses of 30 pounds each.

Treatment of seeds.—As the juar crop often suffers from smut disease the seed for sowing should be treated with copper carbonate at the rate of one ounce for 48 pounds of juar seed or powdered sulphur ½ ounce for 24 pounds of seed.

Sowing.—It has been found that roughly speaking a Ramkel juar plant for fodder purposes requires about 48 square inches of area for its best development. In order to have a good stand of fodder therefore in one acre, there should be (43,560 x 3)=130,680 plants. As 16,000 seeds of Ramkel juar go to weigh one pound, 130,680=8 to 9 lbs. of seed are theoretically required to sow an acre, but allowing 50% seed sown to be ineffective, 16 to 18 lbs. of seeds are usually required. This quantity of seed to be sown however will depend to some extent on the variety and the character of the soil. It should be sown early enough i. e. about the 3rd or the 4th week of June in order to have plenty of time to enable it to come to heads by the middle of October. The seeds are sown 15″ apart, either with a 4 tined Argada at the rate of 20 lbs. per acre or a five tined Walker Seed Drill at the rate of 15 lbs. per acre, keeping the plants 3″ apart in the row. Sowing as thick as this permits a very considerable setting of ears, although not so large a proportion as to make the silage too rich in digestible carbohydrates. After the sowings are finished, the brush harrow is worked across the field to cover the seeds and level the land. Germination takes place within 6 days i. e. the 1st week of July. In case the germination is not even, the field is bukhered and resown immediately.

Interculture.—When the plants are about 9″ high, the Akola hoe is worked in between the rows and when the plants are about 15″ high one thorough weeding is given. The intercultivation is continued till the crop is about 3′ in height, as it destroys the weeds, prevents the undue escape of the moisture, and assists in the decomposition and nitrification of the organic matter in the soil. A thriving fodder crop soon shades the ground and thereby the weeds are more or less suppressed. The luxuriant growth of the crop makes further intercultivation operations impracticable and unnecessary.

Top dressing.—The growth of fodder crop is accelerated by the application of 100 lbs. of Ammonium Sulphate per acre. As the plants do not make rapid progress in their early stage until the end of July, a large application of quickly available nitrogen at such a time becomes necessary. When the plants are 20″ in height, the above quantity is applied between the rows and mixed with the soil by working carefully the hoeing implements.

The first hoeing is done up to a depth of 3″, then gradually it is made shallower as the plants grow up, in order to avoid cutting off the roots, which soon ramify in every direction.

Diseases of Juar.—The growing of juar for fodder purposes is beset with several difficulties in the way of diseases and pests. Of these, the first is Striga agia, a weed which is a parasite on the juar roots; the other is the juar smut, which is the most serious disease of the grain crop but affects the fodder crop less, as it is harvested before the heads are completely formed. There are other diseases also but they are less serious, as they do comparatively little damage to the crop. (1) Agia *(Striga densiflora)*—This parasitic plant occurs quite frequently in the open grass land and from there it spreads to the adjacent cultivated fields of juar and sugarcane. Its seeds remain in the soil without germinating, until a suitable host like the juar plant is available, when they germinate, attach themselves to the roots of juar plant and draw all their nourishment from it. The seeds of the *agia* are found to germinate even a foot under the soil. The parasite grows up and comes to the surface some weeks later to mature its own flower and seed. Owing to this, the juar plants remain stunted and never reach their proper height. When the seeds of *agia* germinate and appear above the ground, a prompt uprooting and burning will remove it and clear it away from the fields. Those occurring on the juar plants, flower within three days of their appearance above the ground and fructify within a week. Each flower produces about two hundred seeds which are spread rapidly unless the uprooting is very prompt and complete. On a large and healthy plant of juar, the weed takes longer time to mature than when it is on a poorer host. (2) *Smut*—Smut is the disease which is really of importance to grain juars. When the plants are attacked by smut, the grains of the whole or a part of the ear-head are turned into black powder consisting entirely of the spores of smut. The disease is carried by the spores sticking to the seeds. These when sown carry with them the smut spores, which also germinate along with the juar seed, get into the stem and later attack the earheads of the juar. It can be easily controlled by treating the seed, before sowing, either with copper carbonate or sulphur as already described.

Insect pests of Juar.—There are two kinds of insects which attack the juar crop:—

(1) The Juar borer (*Chilo simplex*) is the most important and is widely distributed throughout the juar growing tracts. The caterpillar attacks the young stem which dies off but throws out tillers which produce new shoots.

(a) There are several broods of this pest in a year. The caterpillar usually spends the cold weather hibernating in the stubbles of the juar or other allied crops. They become active during the months from March to June, if there is something on which they can feed. A very effective method of attacking the pests is to dig up and remove all the juar stubbles of previous crops during the early part of the hot weather and burn them. This kills all the hibernating caterpillars.

(b) During the growth of the crop, all affected plants are to be pulled out and fed to cattle without delay. This prevents to some extent the further multiplication of the pest.

(c) It is better to have a well-planned cropping scheme in which the juar crop does not come often in the regular rotation. In short it is a pest which cannot be attacked by direct means with insecticides. It is only by constant watchfulness by digging up and burning the stubbles of the previous crop, by the removal of the affected pests in time that a farmer can hope to deal with this pest successfully.

(2) **Juar grass hoppers**.—Certain grass hoppers attack juar and do great damage. A wingless grass hopper (*Colemannia sphenorioides*) inflicts serious damage to the crop at various stages. They appear as young hoppers at the beginning of the monsoon just at the time when the seedlings of juar appear above the ground. They remain active until the end of September and lay eggs in the soil which remain unchanged until the following monsoon. There is thus only one generation in the year. These hoppers feed, at all stages, on the leafy growth of the plant. In Central Provinces however only *Chrologomus sp.* attacks the crop in its early stage (seedling stage).

Remedy :—

(a) The eggs are destroyed by ploughing the land in cold weather with soil inverting plough.

(b) The young hoppers may also be caught in nets.

Disposal of the crop.—There are a number of ways in which this can be done. The standing crop of Juar is either fed green by soiling system or by turning it into silage or fed dry by making it into hay or by feeding it as kadbi-(juar fodder after removal of heads from the stem). The fodder however is more digestible when it is fed as succulent green fodder.

Soiling.—The green feed is cut and carried to the livestock daily, as much as is required. This however, is feasible near the cities where labour is cheap. It is not economical to allow the fodder crop to stand long in the field, as it will ripen and then the fodder is not as nutritious as when it is succulent. As the crop ripens, the soluble food materials are transferred to the seed where they are stored in an insoluble form for future use. Besides this, the leaves which are more nutritious than the stem are lost. When a juar fodder crop is allowed to ripen, major portion of its leaves are generally lost before it is made into either hay or kadbi.

Silage.—To meet the above difficulty of retaining the green succulent fodder in a natural condition, there is an economical way of preserving it in a silo. An air tight receptacle in which the green fodder is preserved, is called a "Silo"; while the process by which the fodder, in green and succulent condition, is preserved for cattle feeding is called "ensilage" and the resulting product is called a "silage".

Making of silage is not a new thing or a new discovery. The Romans in times of the Caesars placed the green leaves of plants in underground, air-tight pits and obtained a palatable feed for their livestock, The making of silage from grass, juar or maize has been done since 1884 in different parts of the province and was found to be successful in all cases. The production of silage nowadays has come to form a supplementary feed for livestock kept on the farm, as a succulent portion of the daily ration has now been definitely established to be a necessity on all the Government Dairy and Cattle Breeding farms. In times of draught and the consequent shortage of fodder and pasture, the value of silage is enhanced, out of all proportion to its cost of production which is by no means prohibitive.

Advantages.—The advantages derived from the making of silage are summarised below :—

(i) In tracts, where owing to an unfavourable season, there appears little prospect of securing a good crop of grain juar in a fully matured condition, the standing crop of juar can be utilised in making a silage by cutting it out in green stage.

(ii) By ensilage, fodder can be stored so as to retain its natural moisture which cannot be so retained by any other method.

(iii) The chemical changes which take place in the silo, increase the digestibility of the fodder.

(iv) In hot and dry period of the season a supply of succulent fodder is secured at a time when all other plants are dried up, unless cheap irrigation is available for raising fodder.

(v) It has been found that by feeding silage, especially made out of juar, to milch animals, milk flow is maintained longer than in the case of animals fed on dry fodder.

(vi) Less space is required to store the chaffed fodder than that required by hay or kadbi.

(vii) There is less likelihood of theft or fire when the fodder is stored in the silo.

(viii) There is no wastage in feeding in case of the silage, as every bit of it is eaten by the animals.

(ix) The carrying capacity of one acre of fodder juar is increased from 25 to 40 per cent when the green crop is stored as silage instead of as hay.

(x) By this method, a green and succulent fodder can be preserved for future use during a time of plenty and used for summer consumption when there is a scarcity of green and succulent food.

Chemical changes in silage making.—It will not be out of place to describe here, in short, the changes taking place in the pit, during the process of the making of the silage. When green and succulent material is heaped up in the pit, it becomes mouldy wherever the air can get at it while it becomes hot and turns dark in colour in the interior of the heap. If there is an access of too much air, the whole of the green material rots. When however it is heaped up in a closed, air-tight space, as in silage making, the interior becomes very hot. The heat produced is due to the fermentation of the vegetable matter stored in the air-tight receptacle. The fresher the green stuff, the greater is the rise of temperature. On the other hand, if the material has been left in the fields for some time, the heat produced when it is put into silo is much less, as most of the stuff has already dried.

During the stage of fermentation of silage, all the oxygen present in the silo is used up by the fermenting organic matter; but further changes still occur. Some of the organic compounds, especially sugar in the material get decomposed, giving the material an alcoholic and pleasant smell. During this part of the process however, the temperature gradually sinks and the anærobic bacteria present, become active. The access of too much air however, to the green succulent material in the pit results, firstly, in fermentation and later in slow burning and finally in loss of digestible food substances and should therefore be avoided. The first thing, therefore, is to regulate the air and reduce the fermentation. The best silage is obtained when it is made at about 130°F and is called sweet silage, while the silage produced below 90°F, has got an acid taste and is called " Sour silage." Thus the sourness or sweetness of a silage is determined mainly by the temperature at which the fermentation takes place in the material. The temperature in the interior of the mass is largely regulated by the pressure and the amount of oxygen within the silage. The silage is sour or sweet according to the amount of certain organic acids present in the prepared stuff, principally acetic, lactic and butyric. Sweet silage is obtained when the silo is filled slowly, as the initial rise of temperature is greater, and hence many bacteria are destroyed. If however it is filled rapidly, the rise in temperature is checked and sour silage is obtained. During this process the appearance of the material also changes considerably. The colour becomes darker though it usually retains some of its original greenness. This also depends on the temperature during the early stages.

The advantages and disadvantages pertaining to sweet and sour silage may briefly be described as follows :—

Sour silage contains the largest amount of feeding matter, because the carbohydrates have not been destroyed to such an extent during fermentation as in the sweet silage. The rise in temperature of sweet silage is due to oxidation and is therefore injurious to the carbohydrates which are wasted. Sour silage however possesses a strong odour which is considered generally to be unpleasant and which has certainly a prejudicial effect on the flavour of the milk, while sweet silage does not possess this unpleasant smell. Sweet silage on the other hand has a rather fruity and alcoholic smell, while sour silage smells of the acids formed during the process of making silage.

Methods of making silage.—Several methods of making silage were used on the Nagpur Farm since the year 1906 and the cheapest was as follows: Juar crop is stacked uncut on the high ground in the open or under the sheds and subjected to high pressure. When it is completely pressed, the whole stuff is covered with straw and earth about one foot deep. The sides of the stack are trimmed down to prevent uneven surface. Though this method of making silage is found to be cheap, it is not economical in the long run, as only about half the edible material is obtained and the remaining green and succulent matter is wasted and thrown into the manure pit. When however the long stalks of juar were stacked underground with or without any shade, the loss was less but still it was much more than in the case of the chaffed stuff in the silo. When juar bundles are stored in under-ground pits, more labour is required at filling time and there is greater chanc of entrapping air and causing wastage. It also adds extra trouble and labour at feeding time. There are three methods of producing silage, in common use, in different parts of the world, according to which the material is stored in a tower, stack or pit. The former has been found to be successful in the western countries, but its initial cost of production, puts it beyond the reach of many of the Indian farmers. Besides this, it was however observed that there was a great loss of valuable food material in the tower silo, as found out by continued trials carried out on this farm for 15 years from 1921 to 1936. The results of the trials of the stack are also not satisfactory.

The most convenient type of silo suited for the climate of this province is the system of the pit, which may be either circular or rectangular, as the trials of the last 40 years have shown. It is also cheap to construct and can be made at any place where there is sufficient drainage and of any size convenient, increasing the length and breadth of the pit. Under ordinary circumstances, a silo built about one third above the ground and about two thirds below the ground has been found to be most convenient, on the Nagpur Farm where the silage is made in 50′x16′x10′ rectangular pit. The loss in this pucca silo amounts to less than 5% of the total stuff stored. In the long run a pucca pit has been found to be more economical than a kacha one on this farm.

In cross section, a silo may be square, rectangular or round. When an overhead silo is to be built, the circular form is the best and the strongest. If a silo is to be built underground, the rectangular type is equally good, provided the corners are rounded off so that the material can be closely packed against the walls. On the Nagpur Farm there is a pucca rectangular pit with a cement concrete bottom and tin roof, as the silage is allowed to remain in silo during the early parts of monsoon (July and August).

Material used on the Nagpur Farm in making silage.—Almost any green crop that makes good fodder will make good silage. Fodder juar makes the best silage though it is expensive to grow. The highest yield of juar grown for fodder obtained on the Nagpur Farm was 21 tons of green and succulent fodder and its cost of cultivation was more than Rs. 60/- but, at an average, the outturn varies from 10 to 16 tons of green fodder. The average outturn of green fodder on the Nagpur Farm comes to 13 tons per acre.

Time of harvesting fodder juar for putting it into Silo.—The general rule to be followed in harvesting the crops grown for the silage is as follows:—

(1) Grass should be mown as soon as the majority of the grasses are in bloom,

(2) Berseem, when the whole crop is in flowers.

(3) Other legumes when the pods are forming but before they are beginning to fill.

(4) Oats and other cereals like maize, bajra and juar, when the grain commences to form. It is best to harvest the juars shortly after full bloom when the seed has begun to form (milky condition). The proper condition of moisture for harvesting fodder juar to be put into a silo is when the moisture in the leaf stalk does not drop down on being twisted and it is drawn in when the pressure is removed. It does not matter if a few leaves at the bottom have become dry. If the harvested stuff contains more than 60 per cent of moisture, it is better to cut and allow it to wilt for half a day or so before putting it into the silo.

Method of harvesting.—Harvesting of the standing crop, chaffing and filling it in the silo should follow one another immediately for successful silage making. On no account should the harvested stuff be allowed to dry either in the fields or in the chaffing ground. If owing to climatic conditions or any important farm work, the silo filling is to be stopped, the harvested stuff should be carted and heaped in small quantities near the silo. Once when silo filling is started, it must proceed steadily without stopping for more than two days between the successive fillings, as it has been found that mould is often formed near the exposed surface within three days. Hence fresh chaffed material must be added at least every three days until silo filling is finally closed.

The ordinary way of harvesting the juar crop is by hand labour, but it requires, on an average, about 45 coolies per acre per day of 8 hours to harvest one acre of juar grown for fodder, so that it becomes very expensive to harvest the 13 ton crop with hand. It has been found very economical to harvest with bullock power mower about 6 acres of crop per day to continue the work of filling the silo properly. The labour required for this is 4 pairs of bullocks worked in relays and 3 men to drive the machine and bullocks and 10 coolies to gather the harvested stuff. The labour required to cart the harvest from the field to the silo is 6 carts, 6 pairs of bullocks and 6 men to drive the carts and 6 men to fill the cart.

Chaffing.—The juar stalks brought to the silo should be cut into ½" to ¾" long pieces, as it is easier to pack the Silo at the sides so closely that air may be completely excluded. As there is considerable shrinkage of the material during fermentation, the mass contracts and moves towards the centre, thus leaving a space between it and the side walls. This space admits air and causes a certain portion of the material put in the silo to become mouldy. The finer the cutting is done, the better, because there is more even distribution of the cut stuff which settles down more evenly and prevents the ready access of air, due to which there is less loss than in that of long silage.

An ordinary lever fodder cutter (No. 10 from U. S. A. or Allost fodder cutter) is quite useful in chaffing the fodder to be filled in the silo. The power fodder cutter worked by the bullock gear or a small oil engine is more economical than a hand-power one, particularly when large quantities of fodder are to be dealt with, as on the Nagpur Farm where the juar crop from 40 acres are chaffed and filled in the silo.

Practice of making pit silage.—Whatever material is selected for the purpose and if it is to be made into good silage, it is placed in the pit in the green succulent stage after chaffing it into fine pieces. This finely cut stuff is heaped daily about 2 feet in layer in the morning and it is evenly distributed and well pressed under the feet of bullocks. It is very important to guard against air penetrating the sides of the pit, as the shrinkage takes place sideways as well as vertically, so that it is very important to trample down heavily the material at the sides of the silo.

In the evening, the same process is repeated by filling the second layer to two feet and pressing it down well. This goes on till the filling of the silo is complete.

It is of considerable advantage to dust some common salt over the green material as it is being filled in layers of two feet at the rate of one hundred pounds for every ton of green fodder. This makes the silage more palatable to the livestock.

Wetting.—Besides the exclusion of air the presence of sufficient moisture is necessary for good silage. Green juar in its normal state contains about 50 per cent of moisture by weight when it is harvested. When dry or partially dry fodder is used, it becomes necessary to add some water to the silage, while it is being made, to make up the deficiency. In such cases one and a half to one ton of water is added to each ton of fodder when the stalks are still pliable but not brittle, in case of dry fodder however two tons of water per ton of fodder are added. It must be borne in mind that the water added cannot take the place of the natural juices and help in the activity of living cells. Too much water however should not be used, as it washes away the natural juices and sugar. The adding of water should be even and regular, so that the whole stuff is equally moist. If an ensilage cutter with blower, run by 8 B. H. P. Engine, is used, the work of filling the silo is facilitated and is finished economically and in time. The silo should be filled in slowly, within a week, filling in daily about 2 feet layers of well pressed finely chaffed fodder, when the silage obtained becomes sweet. The labour required to run the engine is one mistri, one boy and one coolie; while that required for running the fodder cutter would be one mistri, one man, one boy and 5 feeders. Though there are advantages in this practice of chaffing the green succulent fodder, there are also considerable disadvantages owing to the requirement of great amount of men and bullock labour which must be considered beforehand, as 44 well trained and strong men and 12 pairs of good sized strong bullocks are necessary to carry on the work of harvesting and carting of the fodder, chaffing, filling and pressing of the chaffed stuff in the silo, at the busy season of sowing cold weather crops and harvesting and threshing of kharif ones.

Topping and covering.—When the silo is filled to the required height i. e. about 3 to 4 feet above the top level of the silo, the stuff is left to settle down for a day or two and is well pressed under the feet of bullocks for six hours with a view to exclude the air from the silage. It is then covered with fine chaffed waste grass about 3" deep and with earth about 12 inches deep. The earth is banked up against the sides first and then on the top, so as to make it air and water tight. The depth of the earth layer put on is 15 inches in the centre. This covering of the earth is so arranged as to give a gentle slope all round like the roof of a house so that any water falling on it may run off quickly. As the contents of the pit begin to shrink, cracks are formed in the earth layer put over the pit. These cracks should be closed up promptly so that air and water may not enter inside.

Keeping quality.—A silage which has been properly filled, packed and covered remains in good condition for 9 months. The actual process of converting green fodder into silage occupies from 60 to 200 days; but it is generally used for feeding after two months of its being put into the silo. In western countries, it is said to remain in good condition for a number of years, but no such experiment for testing this has been tried on this Farm

Opening the pit for feeding.—The silage is removed for feeding from one end of the trench. The layer of earth covering is removed from that end in sections of sufficient width (3 feet) to permit easy removal of the silage and at the same time as little of the contents as possible is exposed to the air. As the exposed surface is generally spoiled, the width of the slice is chosen to suit the size ofthe herd.

Loss.—On removal of the earth covering, it is often noticed that some silage about 3″ in depth at the top has become mouldy and a 3″ layer along the sides of the walls is also spoiled. This is thrown into the manure pit. The loss varies in different years according to the type of the pit used and the condition of the weather in which the silage is made. In dry weather, the loss is the least in a pucca pit but it increases with the increase of moisture in the material at the time of harvest. There is also some wastage at the bottom and the sides of the pit if the material comes in contact with the soil and moisture. The total wastage on the Nagpur Farm was not more than 5% in a pucca pit.

Feeding.—While feeding the silage to the livestock for the first time, it has been found that the animals eat only a little at a time, but once they become acustomed to its smell and taste, they eat it with great relish and finish all that is given to them. It is always better to increase the quantity gradually.

Quantity to be fed per day.—When the animals are accustomed to silage eating, about 40 pounds per head per day in two feeds is sufficient for a milch herd or work cattle, in addition to their usual ration of concentrates. In all other cases silage in addition to usual grazing is considered to be sufficient to keep them in good condition. It may be fed to any livestock on the farm. As a rule 5 pounds per day for each 100 pounds of liveweight of the farmstock is given as a ration and should be strictly observed as shown below:

Kind of stock	Quantity fed per day
Buffaloes ...	... 60 pounds
Cows ...	... 40 „
Heifers of 3 years...	... 20 „
„ 2 „ ...	... 10 „
Work stock ...	... 30 „
Sheep ...	... 4 lbs.
Goat ...	... 3 „
Fowl ...	... ½ „
Camel ...	... 30 „
Deer ...	... 10 „

The daily rations given above are figured for a full allowance of silage and may be reduced proportionately if supplemented with other roughages. Silage on Nagpur Farm is made in sufficient quantities to ensure a steady supply from April to the end of August, when a sufficient quantity of green grass is available for grazing. It is always fed in addition to dry grass, care being taken to prevent scouring which generally occurs, if too liberal a quantity of silage is included in the daily ration.

Feeding value.—Silage of juar is nearly a complete food and is very valuable when it forms a portion of the daily diet. Ten tons of green fodder produce about 7 tons of silage which is equal to 2½ tons of hay of juar. Silage is especially valuable for milch cattle. It increases the flow of milk, makes it richer in cream and the butter sweeter and rich in colour. It supplies green food at a time of the year when green fodder is scarce. The fibre is rendered more digestible by ensilage which is of great importance in considering the value of silage as fodder when compared with hay. During its preparation however, the proteids are partly converted into acids, and cause some loss of food value. As some nitrogenous food, such as cake, cotton seed or legumes is generally included in the ration along with silage, it acts as a mild laxative which ordinarily does no harm. The average composition of juar silage is given below:

Juar silage—exposed to driage

Dry matter	Proteids	Fats	Carbohydrates	Fibre	Food units
39.5	1.9	0.65	21.37	11.2	27

Digestible nutrients per cent

Crude protein	Fats	Carbohydrates	Fibre	*Carbohydrates 2.3 fats Wolff Lehmann.*	*Total digestible nutrients including fibre.*
1.02	.53	15.9	7.8	17.0	25.9

The value of a ton of silage varies considerably according to the kind and quality of material of which it is composed, and also according to the amount of moisture contained therein, in addition to its condition when taken out i. e. whether it is sweet or sour, mouldy or over-burnt, and determines to a large extent its feeding value. It is advisable that it should not serve as an exclusive food, but should always be given along with well made hay or concentrates.

Yield.—The yields vary considerably in different years ranging from 10 to 20 tons of green fodder per acre containing 50 per cent moisture. 13 tons is generally taken as an average outturn of green fodder per acre. The silage from 13 tons would be about 9 tons, so that the total cost of 9 tons of silage is Rs. 71-8-9 at 280 lbs. per rupee. The cost of making silage from fodder juar on an average on the Nagpur Farm comes to -/1/5 per 100 pounds when only the charge for making the silage is considered, while the cost of making silage along with that of raising the crop comes to -/5/9 per 100 pounds, which is cheaper than that of naturally grown grasses which is about -/6/6. Besides this, the making of silage in a pit is simpler than making hay or grass silo.

Thus the advantage of preserving succulent fodder for summer consumption has been recognized at all times but it has been found the difficult to do so. The uncertainty of the climatic condition renders the working of good hay difficult and, in some seasons, impracticable. Hence any additional means of retaining the feeding properties in grasses or other forage plants, without destroying its succulence is of considerable value. This question has been easily and satisfactorily solved by the process of ensilage.

DETAILS OF CHARGES

Male coolies	-/5/-	per day
Female „	-/3/-	„
Bullocks	-/12/-	for mower and -/10/- for carts and other Agricultural operations, per day per pair.

Cotton Waste Gutterfly	3/-	per ton
Ploughing charges	5/15/-	per acre
Hire of C. T. Plough per day	-/2/-	
2 pairs of bullocks per day @ -/10/- per pair	1/4/-	
One man @ -/6/- per day	-/6/-	
2 men @ -/5/- per day	-/10/-	
Area ploughed 0.4 acre per day	2/6/-	i. e. Rs. 5/15/- per acre.

Bukhering charges :—

Hire for bukher	-/-/6	per day
1 pair of bullocks	-/10/-	,,
1 man	-/5/-	,,
Area bukhered 1.50 acres per day	-/15/6	i. e. -/10/4 per acre

Charges for sowing :—

Hire of 4 Coulter drill Argada	-/-/6	per day
1 pair of bullocks	-/12/-	,,
One man	-/6/-	,,
Four female coolies @ -/3/- per day	-/12/-	
Work done 4 acres per day	1/14/6	i. e. -/7/8 per acre

Brush harrow :—

1 pair of bullocks	-/10/-	per day
1 man	-/5/-	,,
Area harrowed 6 acres per day	-/15/-	i. e. -/2/6 per acre

Interculture :—

Hire of a pair of Akola Hoes	-/-/6	per day
One pair of bullocks	-/10/-	,,
2 men @ -/5/- per day	-/10/-	
Area done 3 acres per day	1/4/6	i. e. -/6/10 per acre

Watching charges :—

One man watching 42 acres for 3 months @ Rs. 7/-/- per month = Rs. 21/- i. e. -/8/- per acre (proportionate).

Harvesting with mower :—

Price Rs. 250/- working life 1,000 acres (100 acres per year for 10 years)

Interest	Rs. 71/12/- @ 5/- per cent per annum
Total	Rs. 250/- + 71/12/- = 321/12/- or Rs. 32/3/- per year or Re. 0/5/4 per acre.

Labour charges for harvesting :—

One man @ -/8/-	-/8/-	per day
2 men @ -/7/-	-/14/-	,,
4 pairs of bullocks @ -/12/- per day to be worked in relays	3/-/-	,,
Labour charges for collecting and removing fodder—10 female coolies coolies @ -/3/- per day per head	1/14/-	,,
Lubricating oil	-/4/-	
6 acres area is harvested daily	6/8/-	i. e. Re. 1/1/4 per acre.

Labour charges for carting stuff from 6 acres :—

6 carts and 6 men are required to supply stuff for chaffing

Hire of 6 carts @ -/2/- per cart	-/12/-
Oil	-/5/-
6 coolies to drive the carts @ -/5/-	1/14/-
6 coolies to load the cart @ -/5/-	1/14/-
6 pairs of bullocks @ -/10/-	3/12/-
	8/9/- i. e. Rs. 1/6/10 per acre

Labour charges on Chaffing Floor

6 female coolies to supply fodder @ -/3/- per day	1/2/-
5 Feeders @ -/5/- per day (1 @ -/6/- and 4 @ -/5/-)	1/10/-
1 Cleaner	-/5/-
1 Boy	-/4/-
2 Distributors of chaffed fodder in the pit @ -/5/-	-/10/-
3 coolies to add water @ -/3/-	-/9/-
6 Female coolies to press the sides @ -/3/-	1/2/-
1 Mistri	1/4/-
1 Boy at the engine	-/4/-
1 Female cooly to supply water and coal for engine	-/3/-
1 Mistri at the enginge	1/-/-
Coal 1/3rd ton Rs. 10/- per ton	3/5/4
Lubricating oil for Engine and fodder cutter	2/8/-
Pressing charges for 6 bullocks for 3 days @ -/4/- per day	4/8/-
1 boy	-/2/-
Cost of chopping 6 acres of kadbi in 8 hours	18/12/4 i. e. Rs. 3/2/1 per acre.

Silo pit 50'x16'x8' = 6,400 cubic feet.

Life	20 years
Cost	Rs. 1,000/-
Interest @ 5%	525/-
Repairs	75/-
	1,600/- i. e. Rs. 80/- a year

It holds 6,400 cubic ft. of silage = 110 tons of silage or the Stuff from 12 acres = Rs. 6/10/8

Steam Engine 4 B. H. P. price	2000/-
Interest @ 5%	550/-
Repairs	450/-

Total 3,000/- or 300/- a year

Working days in a year 150 i. e. the charges come to Rs. 2/- per day.
Work done 6 acres, hence the charges amount to -/5/4 per acre.

Fodder cutter with blower costing Rs. 1,000/-
Life 20 years

Interest @ 5%	525/-
Repairs	475/-

2,000/- i. e. Rs. 100 a year.

It chops 80 acres of kadbi every year, hence the charges amount to 1/4/- per acre.

Fencing :—

Fencing 4 miles @ Rs. 1, 200/- per mile	= Rs. 4,800/-
Interest @ 5%	4,930/-
Repairs	270/-

10,000/- in 40 years or
Rs. 250/- a year on 640 acres
or -/6/3 per acre.

Cost of cultivation of Ramkel Juar for fodder on College Farm, Nagpur

		Rs.	A.	P.
1.	Cost of 4 tons Gutterfly @ 3/- per ton ...	12	0	0
2.	Carting charges for above @ 1/4/- per ton ...	5	0	0
3.	Spreading charges for above @ -/6/- per ton ...	1	8	0
4.	Ploughing with soil inverting plough ...	5	15	0
5.	Bakherings 2	1	4	8
6.	Super phosphate 200 lbs. @ 4/8/- per 100 lbs. ...	9	0	0
7.	Spreading charges for above, 2 females @ -/3/- per day	0	6	0
8.	Mixing the manure by bakhering	0	10	4
9.	Picking stubles and weeds, 4 females @ -/3/- per day	0	12	0
10.	Cost of seed—20 pounds @ 24 lbs. per rupee ...	0	13	4
11.	Sowing seed with Argada, 4 tined ...	0	7	8
12.	Working brush-horrow	0	2	6
13.	Inter culture (hoeing)	0	6	10
14.	Weeding with 10 coolies @ -/3/- per day ...	1	14	0

15.	Top dressing of ammonium sulphate 100 lbs. @ Rs. 6/- per 100 lbs.	6	0	0
16.	Labour charges for top-dressing, 2 female-coolies @ -/3/-	0	6	0
17.	Working Akola hoes, twice	0	13	8
18.	Watching charges (proportionate)	0	8	0
19.	Land Revenue	2	8	0
20.	Cess and other taxes	0	3	0
21.	Supervision charges	2	0	0
22.	Fencing charges	0	6	3
23.	Overhead charges for roads, etc.	1	0	0
	...	54	1	3

Cost of Making silage

1.	Depreciation on mower	0	5	4
2.	Repairing charges, etc.	0	4	0
3.	Labour charges for harvesting	1	1	4
4.	Depreciation on silo pit	6	10	8
5.	Dep. on Engine	0	5	4
6.	Dep. on fodder cutter	1	4	0
7.	Carting—12 tons	1	6	10
8.	Chopping	3	2	0
9.	Contract charges for covering earth per acre ...	1	0	0
10.	Overhead charges	2	0	0
	...	17	7	6
	Total cost of growing and silage making of juar fodder ...	71	8	9

Hay.—The making of hay from especially grown juar fodder is not very convenient, in as much as the crop, grown during the rains, is ready at a time when the climatic conditions are not quite suitable for drying the green material properly and converting it into hay. If so made however, it should be perfectly dry, otherwise it will turn black and become mouldy. The following method of making hay may be followed, when the necessity arises to turn it into hay.

As soon as the juar crop is in heads, it may be mowed down and allowed to remain on the ground for drying. If the cut material is heaped thickly, it should be turned over in order to expose the lower portion to the sun for a day or so. The partially dried stuff is then made into cocks (small heaps) and allowed to remain so, for two or three days when fermentation takes place. This may be detected by the production of heat and the depositing of moisture in the interior of the cocks. When thoroughly warm and before the hay loses it natural colour, the cocks are opened up exposing the hay to the sun for four to six hours according to the size of the cocks, when it becomes perfectly dry. The hay is then placed in stacks, where it is allowed to remain till required.

Cost of making juar hay :—

Cost of raising juar fodder in one acre	54	1	3
Harvesting charges	1	10	8
Tying of the cut material into bundles 10 men @ -/5/- per man	3	2	0
Charges for turning out the bundles for drying 8 men @ -/5/- per man	2	8	0
Putting the bundles into cocks—6 men ...	1	14	0
Reopening and exposing the fodder—6 men ...	1	14	0
Stacking the hay—6 men	1	14	0
7 tons of juar hay will cost	66	15	11

i. e. 234 lbs. per rupee.

Chopping and storing :—

Cost of juar hay	66	15	11
Setting charges of machines	0	5	4
Depreciation on a dutch barn	7	9	3
„ on a Fodder cutter	1	4	0
„ on Engine	0	5	4
Carting of 7 tons of hay	1	6	10
Chopping	1	9	0
Overhead charges	2	0	0
Chopped juar hay (7 tons) costs	81	7	8

i. e. 192.5 lbs. per rupee.

The crop of juar, when not required for making of silage or hay may be allowed to grow about a fortnight longer for allowing the grains to mature. The crop may be harvested before it is dead ripe or before the leaves begin to wither; such a crop will yield about 1,200 pounds of grain of smaller size and 6 tons of kadbi of rather inferior quality owing to the crop being allowed to ripen the seeds.

Cost of fodder including harvesting and storing:—

Cost of raising the crop	54	1	3
Harvesting	1	1	4
Removing crops, 30 coolies @ -/3/-	5	10	0

Threshing, (3 men and 8 bullocks)	2	15	0
Winnowing charges @ -/2/- per 100 lbs. ...	1	8	0
Tying of kadbi in bundles 10 men @ -/5/- ...	3	2	0
Carting of Kadbi	1	6	10
Chopping charges	1	9	0
Depreciation on mower, Engine, etc.	9	3	0
Overhead charges	2	0	0
	82	8	5
Value of 1200 lbs. of grain @ 40 pounds ...	30	0	0
	52	8	5

i. e. 256 lbs. per Rupee

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PRE-TREATMENT OF COTTON SEED WITH AMMONIUM SULPHATE

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Introduction.—Placement of fertilizers appears to be an important factor governing the response of a crop to fertilizer application.

In the case of cotton, the usual methods of applying Ammonium Sulphate at the time of sowing are:

(i) drilling the seed first and dropping the fertilizer by hand later in the opened out furrows and finally covering them up, or

(ii) drilling the fertilizer with dry seed itself.

A still more convenient method would appear to be to sow the cotton seed coated with Ammonium Sulphate. The coating with Ammonium Sulphate is best done when the seed, in a slightly moist state, after treating it with earth and dung paste, is mixed up with dry Ammonium Sulphate. Maximum amount of Ammonium Sulphate that can be coated round the seed depends upon the variety having a big or small size seed and the seed rate used. In the case of V. 434 cotton seed, it is estimated that Ammonium Sulphate equivalent to about 20 lbs. of Nitrogen per acre can be coated round it, the seed rate being 20 lbs. per acre. The number of seeds per Gram weight is 14.69 in the case of V. 434 cotton.

Observation plots.—Observation plots, each of 1/5th acre size, were arranged in duplicate at Government Seed and Demonstration Farm, Khandwa, during the year 1940-41 with a view to studying the effect of sowing V. 434 cotton seed coated with Ammonium Sulphate in the above manner. The seed rate for cotton was 20 lbs. per acre and Ammonium Sulphate equivalent to 7 lbs. of Nitrogen per 20 lbs. of the seed was taken for coating the seed. In the early stages of growth the effect of the treatment compared to the control was distinctly noticeable. The treated plots had a better stand and had an early start and vigorous growth but the difference subsequently became imperceptible and no difference in yield was observed. The treated plots, however, were earlier to mature.

Manurial experiment.—A regular experiment was planned at the Khandwa Farm during 1941-42. The crop was raised without irrigation as is the usual practice. Seed rate was 20 lbs. per acre. Treatments included were:

1. Control.
2. 10 lbs. N in the form of Ammonium Sulphate coated round the seed.
3. 10 lbs. N in the form of Ammonium Sulphate top-dressed three weeks after sowing.

4. 5 lbs. N as Ammonium Sulphate drilled with dry seed + 5 lbs. N as Ammonium Sulphate top-dressed three weeks after sowing.

The experiment was of a randomised block type with five replications, the plot size being 1/40th of an acre.

The experiment would have been of more value if the treatment in which 10 lbs. of Nitrogen in the form of Ammonium Sulphate drilled with dry seed was also included so that the specific effect of coating the seed with Ammonium Sulphate as against drilling it with dry seed would have been investigated. The experiment would be suitably modified in the following season.

Agricultural operations.—Groundnut crop was grown in the previous year. The plots had received one ploughing and one bakhering before sowing. The seed was sown on the 6th of July 41, the seed rate being 20 lbs. per acre. One weeding was done on the 16th of July and two hoeings given, one on the 25th July and 2nd on the 4th of August 1941 and top-dressing with Ammonium Sulphate was done on the 4th of August. Distribution of rainfall during the growing period of the crop is given in appendix I. Three pickings of cotton were taken, the first on 25th November 1941, 2nd on the 5th of January and the final picking on the 29th and 30th of January 1942.

Observations on crop growth.—The experiment was under observation during the growing period of the crop. Plots treated with 10 lbs. of Nitrogen coated round the seed were much advanced in growth from the start and matured earlier. The control plots were the last to mature. While in the treated plots 73 to 74 per cent of the produce was picked in the first picking and about 23 to 24 per cent in the second, in the control plot 68 per cent was picked in the first and about 28 per cent in the second picking. The number of bolls observed for the treated plots was more than the control, that in which the seed was coated with the fertilizer showed the highest bearing. The size of the bolls in plot where the seed was coated with the fertilizers appeared to be larger. No actual measurements were, however, taken.

Analysis of variance of yields.—The actual yields obtained per plot per picking are given in appendix II. Analysis of variance is given in table I and the mean yields together with the standard error are shown in table II.

TABLE I

Analysis of Variance of yield

Due to	D. F.	Mean square
Blocks ...	4	1.999
Treatments ...	3	38.926
Error ...	12	3.145
Total...	19	

TABLE II

Mean yield in lbs.

	Treatment					
Yield	Coated	Top-dressed	Half drilled + half dressed	Control	Mean	S. E.
Per acre ...	644.0	443.2	456 8	387.2	482.8	31.72
Per cent of mean	133.8	91.8	94.6	80.2	100.0	6.57
Per cent of control	166.3	114.5	118.0	100.0	...	...

Discussion.—It will be observed from the above that the treatment effect is significant compared to the control. The detailed analysis, however, indicates that the only treatment in which 10 lbs. of Nitrogen in the form of Ammonium Sulphate is coated round the seed has given statistically significant higher yield compared to other treatments. About 66 per cent increase in the yield has been obtained over control in this case while in the other treatments the yields are higher by 14 to 18 per cent over the control but are not statistically significant.

In this connection observations of Crowther (1) are of interest. He records that manuring results in more and often larger bolls and consequently in extra final yield. From the experimental work in Egypt and elsewhere on the movement of nutrients within the plant following fertilizer application, he has shown the influence of the branching habit of the cotton varieties on the optimum date of application of fertilizer. He observes that for the Neglectum cottons of Berar, the Central Provinces and Khandesh, there is a need for an early application of the fertilizer as indicated by the plants' morphological characters. Here the growth is stunted ; monopodia are unimportant for yield ; sympodia are formed low down the main stem and fruiting is abundant on these lower branches. The crop is thus an early one having a short growing season and the bolls appear in a rapid flush. These characteristics point to an early application of the fertilizer and apart from effects of rainfall distribution application at or even before sowing should prove optimal.

His above findings are borne out by the various experiments conducted on the manuring of cotton in this province. Adequate rainfall must be assured if late application is to be thoroughly incorporated into the soil for plant utilization and which generally is absent in these tracts.

The 66 per cent increase in the yield obtained by merely coating the seed with Ammonium Sulphate equivalent to 10 lbs. of Nitrogen per acre is indeed phenomenal. The results of the previous experiments show that such a high percentage in increase in yield is not usually obtained even by the application of a higher dose of 40 lbs. of Nitrogen per acre either in the form of organic or inorganic manure or mixture of the two. The efficiency and economics of manuring in the form suggested namely, coating the seed with the fertilizer are clearly indicated.

Summary and conclusion.—The paper discusses the results of the manurial experiment on V. 434 cotton at the Government Seed and Demonstration Farm, Khandwa, for the season 1941-42. Treatments included were.

1. Control.
2. 10 lbs. N in the form of Ammonium Sulphate coated round the seed.
3. 10 lbs. N in the form of Ammonium sulphate top-dressed three weeks after sowing.
4. 5 lbs. N as Ammonium Sulphate drilled with dry seed + 5 lbs. N as Ammonium Sulphate top-dressed three weeks after sowing.

The important conclusions are:—

(i) Application of fertilizer at the time of sowing appears to be better than applying it as a top-dressing.

(ii) The best way of applying the fertilizer at the time of sowing is to coat it round the seed before sowing. The increase in yield obtained by this method is 66 percent over the control, the increase which is not usually obtained even by the application of 40 lbs. of Nitrogen per acre in the usual manner. Coating with Ammonium Sulphate is best done when the seed, in a slightly moist state, after treating it with earth and dung paste is mixed up with dry Ammonium Sulphate.

(iii) The treated plots are earlier to mature and have a better bearing and larger size of bolls, those in which the seed is coated being the earliest to mature.

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APPENDIX I

Statement showing the rainfall record at the Government Seed and Demonstration Farm, Khandwa, during the year 1941-42

Record of Rainfall in inches

Date	April 41	May 41	June 41	July 41	August 41	September 41	October 41	November 41	December 41	January 42	February 42
1.	...	...	...	1.97	...	...	...	...	...	...	...
2.	...	...	...	1.48	.43	...	...	...	...	...	...
3.	...	...	...	2.49	.05	...	...	...	...	...	...
4.	...	...	...	.05	...	...	..	...	...	...	.72
5.	...	...	.23	.24	...	...	...	...	...	...	...
6.	...	...	...	.01	.32	...	...	...	...	...	...
7.	...	...	...	.14	..	...	...	...	...	...	...
8.	...	...	...	...	...	...	...	...	...	...	...
9.	...	...	...	...	1.97	...	...	...	...	...	...
10.	...	...	...	...	.25	...	...	...	...	...	...
11.	...	...	...	.07	2.14	...	...	...	...	...	...
12.	...	...	...	7.00	.04	...	...	...	...	...	...
13.	...	...	...	.82	...	...	...	...	...	...	...
14.	...	...	...	.07	...	...	...	...	...	...	...
15.	...	...	...	...	...	...	...	...	...	.06	...
16.	...	...	...	...	.09	.01	...	...	...	...	...
17.	...	...	...	...	.56	3.26	...	...	...	...	...
18.	...	...	...	...	.10	.53	...	...	...	...	...
19.	...	...	...	...	1.50	...	...	...	...	...	...
20.	...	...	...	...	.07	...	...	...	...	...	...
21.	...	...	...	...	.01	...	...	...	...	...	...
22.	...	...	...	...	...	...	...	...	...	...	...
23.	...	...	...	...	...	...	...	...	...	...	...
24.	...	...	...	...	...	...	...	..	...	...	...
25.	...	...	...	...	.20	.09	...	...	...	...	.21
26.	...	...	...	...	...	.47	...	...	...	...	...
27.	...	...	...	...	...	.03	...	...	...	...	...
28.	...	...	...	...	...	...	...	...	...	.05	...
29.	...	...	...	...	...	...	...	...	...	...	...
30.	...	...	2.05	...	...	...	...	...	...	...	...
31.	...	...	...	.03	...	...	...	...	...	...	...
Total	...	...	2.28	14.37	7.73	4.39	...	...	...	0.11	0.93

APPENDIX II

Yield of Cotton in lbs. per plot.

Replication		Treatment				
		10 lbs. coated	10 lbs. top-dressed	5 lbs. drilled+ 5 „ top dressed	Control	Total
I.	1st picking	16.5	8.5	8.5	6 0	
	2nd „	3.5	2 0	2.0	2.0	
	3rd „	0.5	0.3	0.2	0.5	
	Total	20.5	10.8	10.7	8.5	50.5
II.	1st picking	12.0	8.5	8.5	6.0	
	2nd „	3.5	3.0	3.0	3 0	
	3rd „	0.5	0.2	0.4	0.4	
	Total	16.0	11.7	11.9	9.4	49.0
III.	1st picking	11.5	9.0	8.0	7.0	
	2nd „	4.5	2.0	2.0	3.5	
	3rd „	0.2	0.3	0.3	0.3	
	Total	16.2	11.3	10.3	10.8	48.6
IV.	1st picking	10.5	6.0	10.0	8.0	
	2nd „	4.0	4.0	3.0	3.0	
	3rd „	0.3	0.3	0.4	0.4	
	Total	14.8	10.3	13.4	11.4	49.9
V.	1st picking	9.5	8.5	7.5	6.0	
	2nd „	3.0	2.5	3.0	2.0	
	3rd „	0.5	0.3	0.3	0.3	
	Total	13.0	11.3	10.8	8.3	43.4
	„	80.5	55.4	57.1	48.4	241.4

FIBRE CONTENTS OF INDIAN LINSEED VARIETIES

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AND

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I. **Introduction.**—As a substitute for flax, the possibilities of combining the production of linseed with that of flax fibre have been the subject of numerous experiments in this country for over a century, but no appreciable success has so far been achieved. The straw left after threshing out the linseed crop, is either thrown away as waste matter or is burnt as fuel. The utilisation of this part of the plant is, therefore, an important economic problem of India, since cultivation of linseed in this country exceeds four million acres yielding nearly 1,000,000 tons of straw.

Experiments conducted in this direction at the Oil seeds Research Laboratory, Nagpur, during the past five years (Richharia, 1938 a, b; 1939; 1940 a, b, c; and 1941 a, b, c, d)*, have shown that the Indian linseed plant grown for seed is also capable of yielding a high quality fibre which may provide a basic raw material for the establishment of a number of industries, such as textile, cordage, paper-making, etc. The aim of the present investigation is to determine the variability in the fibre content among the different promising linseed varieties grown in the Central Provinces and Berar and those grown in other parts of India, with a view to select a high yielding (seed) variety, with the maximum fibre content to be realized as a by-product.

II. **Material and Technique.**—The following varieties were utilised in the determination of fibre percentage.

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*(1938-a).—*Progress Rep. Oilseeds Research Scheme,* ***1937-38****, Govt. of India Press.*

(1938-b).—"Extraction of fibre from linseed stalks"
Leaflet No. ***25*** of 1938, *Dep. agric.* Central Provinces.

(1939).—*Progress Rep. Oilseeds Research Scheme,* ***1938-39****, C. P. Govt. Press,* 10.

(1940-a).—*Progress Rep. Oilseeds Research Scheme,* ***1939-40****, C. P. Govt. Press,* 5 & 6.

(1940-b).—"Linseed Fibre Industry in India"
Curr. Sci. ***9***, 210.

(1940-c).—"A process for extracting fibre from the stalks of the linseed plant, and fibre so extracted"
Patent No. ***27129*** *(2-10-1940), Govt. of India Press.*

(1941-a).—*Progress Rep. Oilseeds Research Scheme,* ***1940-41****, C. P. Govt. Press,* 18.

(1941-b).—"Possibilities of a new industry on linseed fibre in the Central Provinces & Berar".
Proc. Indian Aca. Sci.
A symposium on "the industrial development in the Central Provinces and Berar" held at Nagpur on 26th December, 1941.

(1941-c).—"A machine for extracting fibre from fibrous plants"
Patent No. ***27221*** *(9-7-1941), Govt. of India Press.*

(1941-d).—"Chemical treatment of the coarse fibres of the linseed plant, to render them capable of being spun into yarn."
Patent No. ***27148*** *(26-3-1941), Govt. of India Press.*

S. N.	*Strain*	*Place of origin*
1.	Local	Nagpur (Central Provinces)
2.	Local	Jubbulpore (Central Provinces)
3.	E. B. 3 (ICR I)	Central Provinces
4.	O. S. X. (ICR V)	Central Provinces
5.	No 3255 (ICR VI)	Central Provinces
6.	No. 1193	Cawnpore (U. P.)
7.	No. 1150	Cawnpore (U. P.
8.	No. 1206	Cawnpore (U. P.)
9.	No. 483	Cawnpore (U. P.)
10.	Local	Montgomery (Punjab)

After removing the root and inflorescence parts, the middle portion of the plant with an approximate length of 8 to 10 inches was tied up into bundles, each weighing approximately 40 to 50 grams. After recording the air-dry weight, the bundles were transferred to an electric oven adjusted at 80^{0}C and dried to a constant weight. Later the bundles were immersed in caustic soda (commercial) solution of 0.5 to 1 % strength and boiled for four to five hours till the woody part is pulled out clean and easy from the fibre. The stalks were then washed thoroughly in tap-water and kept for drying. The extraction of the fibre was done by the dry-scutching process (Richharia 1940-c) by employing a specially designed

TABLE I

Table showing the fibre percentage and other details in different varieties of linseed grown in the Central Provinces and elsewhere.

Varieties	Place of origin	Colour and size of the seed	Fibre %	Oil %	Average yield of seed per acre in lbs.
Local (Nagpur)	Central Provinces	Brown, bold	21.0	41 0	250
Local (Jubbulpore)	,,	,,	14.1	...	250
O. S. X. (I. C. R. V.)	,,	Dull, yellow bold	13.76	47.0	360
E. B. 3 (I. C. R. I.)	,,	Brown, bold	11.09	39 0	350
No. 3255 (I.C.R. VI)	,,	Brown, bold	10.01	39.0	350
No 1150 (Cawnpore)	United Provinces	*Brown medium	20.0	38.8	1066
No. 1193	,,	Brown, bold	21.6	40.7	1066
No. 483	,,	Brown, small	20.7	39 8	...
No. 1206	,,	Yellow, bold	17.4	43.1	902
Local (Montgomery)	Punjab		14.35	...	...

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* Reproduced from Leaflet No. 83 (1939) of the Department of Agriculture, United Provinces.

hand-machine (Richharia 1941-c). Fibre extracted from each set was weighed separately. These samples were then transferred to an electric oven to be dried to a constant weight. The fibre percentage is calculated on a constant dry weight basis and each value represents an average of three similar estimations.

III. **Results.**—The fibre percentages as obtained from different varieties of linseed grown in the Central Provinces and elsewhere are shown above in a tabular form. The colour and size of the seed, oil percentage and average yield of seed per acre, previously investigated (Richharia 1940 a-41 a) are also included for comparison.

IV. **General consideration.**—The range of variation with respect to fibre percentage in the Indian Linseed plant cultivated for oilseed of commerce as shown in the above table is sufficiently wide. From the Central Provinces material, O. S. X. (I. C. R. V) promises well in most respects. Average yield of E. B. 3 (I C. R. I.), No. 3255 (1. C. R. VI) and O. S. X. (I. C. R. V.) are alike, but in oil percentage and also in fibre percentage O. S. X. is superior and being dull yellow in colour also fetches a better price in the market. Similarly among the United Provinces varieties, No. 1193 gives a fair promise being superior in fibre and oil percentages and yield of seed.

These observations, therefore, show the possibilities of combining the fibre yielding capacity with higher yields of seed. Since the chief aims and objects of linseed breeding schemes are generally to select out high yielding varieties, it will be an additional advantage to select out from amongst the high yielders, only those with the maximum fibre content to be realized as a by-product. Recent revival of interest in the possibilities of utilising the linseed fibre in a number of industries such as textile, cordage, paper-making, etc. at the Oilseeds Research Laboratory, Nagpur, has shown that linseed fibre production may become an industry of some importance in this country, thus adding more to the profits of linseed growers.

Acknowledgments.—The authors gratefully acknowledge their thanks to the Imperial Council of Agricultural Research for financing the Research Schemes on oilseeds and linseed fibre in the Central Provinces.

ECONOMICS OF COTTON MANURING IN THE C. P. & BERAR *

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Introduction.—Cotton is an important money crop of the Central Provinces and Berar. It is grown over an area of nearly 3½ million acres and represents over 25 per cent of the area under cotton in India. Cotton cultivation is concentrated mostly in Berar, Nimar and some parts of Nagpur and Wardha districts. The percentage of area under cotton in the cotton tract varies from about 28% in the Nagpur district to over 50 per cent in some of the Berar districts.

Research work in respect of the cotton crop is mainly carried out at the Government Experimental Farm, Akola. The soil of the farm is a deep black loam typical of the Berar cotton tract. It is liable to water-logging after heavy continuous rains. In hot weather, it opens out into numerous deep cracks which go to a considerable depth justifying the expression that "*Black Cotton Soil ploughs itself.*"

The sowing of cotton is generally done by the second week of June, usually after the first fall of two inches of rain. The period of quickest growth is during August—September. The crop becomes ready for first picking during October and gives from three to four pickings during its growth period.

Effect of manures.—The results of the manurial trials upto 1930 have been reviewed by Allan (1). Bal (2) has also given a resume of the results of the cotton manurial experiments conducted in the Province. The results of the manurial experiments conducted on the Government Experimental Farm, Akola, during the quinquennium 1935-40 are analysed. As a result of the analysis, it can be broadly said that the percentage increase can be secured by the various treatments as detailed below. The standard error for the mean of the treatment for any experiment can be taken to be 5.5 per cent, indicating roughly that about 16 per cent increase over the control can be regarded as significant. The average yield of cotton is taken as 312 lbs. per acre, the standard outturn. The average yield of the untreated plots under the experiments worked out to 340 lbs. per acre.

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*Read at Agriculture Section, Baroda Science Congress, January 1942.

TABLE I

	Treatments per acre												
	Farm Yard Manure 40 lbs. N.	Cotton stalks compost 40 lbs. N.	Ammonium Sulphate S/A 40 lbs. N.	Ammonium sulphate S/A 20 lbs. N.	F. Y. M. 20 lbs. N + Compost 20 lbs. N	F. Y. M. 20 lbs. N + S/A 20 lbs. N	Compost 20 lbs. N + S/A 20 lbs. N	Groundnut cake 15 lbs. N	Groundnut cake 25 lbs. N.	Groundnut cake 35 lbs. N.	Groundnut cake 10 lbs. N + S/A 5 lbs. N	Groundnut cake 16.7 lbs. N + S/A 8.3 lbs. N	Groundnut cake 23.3 lbs. N + S/A 11.7 lbs. N
Percentage increase in yield over control.	7	10	45	24	12	28	30	21	33	44	23	41	59
Actual increase in lbs. per acre over control assuming it to be 312 lbs. per acre.	22	31	140	75	37	87	94	65	103	137	72	128	184

The other facts which are not brought out in the table but are of interest are (1) the application of potash is not effective, (2) application of phosphate in the presence of Nitrogen increases the yield significantly, (3) the application of manure, half at sowing and half at intensive flowering appears advantageous but the effect appears to be governed by the character of the rainfall following its application. The advantage of supplying 2/3rd of Nitrogen in the form of cake and 1/3rd in the form of Ammonium sulphate, instead of all given in the form of cake alone is evident from the table. The manures indicated in the table are all given at sowing. (4) High residual effects of Farm Yard Manure and Compost and significant residual effect when Groundnut cake is applied at the rate of 25 or 35 lbs. of Nitrogen per acre is noticeable in jowar in respect of grain and fodder. The yields are expected to increase by 15 to 30 per cent by the above application.

Economics of manuring.—An all important question regarding manuring is "Does it pay?" i. e., "Does the money value of the additional crop obtained exceed the price paid for the manures applied?" A significant increase in the yield may or may not be accompanied by a significant profit. The significance of the profit depends on the magnitude of the profit secured in relation to its error, which in its turn, is determined by the price obtaining for cotton and manure. Sukhatme (3) has outlined the approach to the study of manurial trials from this economic aspect. Adopting that method, Table II is prepared showing significance or otherwise at various prices of manures and cotton of extra yields obtained after deducting for the cost of manures applied. In the above table the data in respect of the year of application of manure are considered and not the residual effect of the treatment as well.

Percentage of nitrogen in groundnut cake is taken to be 7.5, that in Ammonium Sulphate 20, and in Farm Yard Manure and Compost 0.7. The cost of Farm Yard Manure is taken at Re. 1/- and that of compost at Re. 0 13-0 per cart-load containing about 11 maunds (4). The prices of groundnut cake have been as high as Rs. 70/- per ton in 1935 while due to war now the cake can be had at Rs. 25/- to Rs. 27/- per ton of 27½ maunds as there is no export for it. The prices of Ammonium Sulphate have now gone up considerably. The average price can be taken to be about Rs. 5/- per maund.

The table at once brings out the fact that the application of Farm Yard Manure or Compost, either singly or in combination with Ammonium Sulphate is done at a loss even when the cotton prices are of the order of Rs. 85/- per khandi of 784 lbs. A nominal profit which is statistically insignificant, is however secured when cotton sells at Rs. 95/- per khandi and 40 lbs. of nitrogen half in the form of either Farm Yard Manure or compost and half as Ammonium Sulphate is applied. Application of Ammonium Sulphate alone also does not result in statistically significant gain even at higher rates of cotton and a low rate of Rs. 4/8/- per maund of the fertiliser.

It has already been stated that it is advantageous to supply 2/3rd of the Nitrogen in the form of cake and 1/3rd in the form of ammonium sulphate, instead of all being given in the form of cake. The response to the application of 35 lbs. of nitrogen, either singly as cake or in mixture, is proportionately much higher in comparison with the responses secured by the application of smaller doses. Even when cotton sells at Rs. 55/- it pays to manure it with 35 lbs. of Nitrogen, 2/3rd being given in the form of groundnut cake and 1/3rd in the form of Ammonium

Sulphate, if groundnut cake sells at Rs. 1/8/- per maund and Ammonium Sulphate at Rs. 5/- per maund, the net profit secured being of the order of Rs. 3-6-0 per acre. If cotton sells at Rs. 75/- the profit secured at the above rates of the manures exceeds Rs. 8/- per acre, the extra investment required being about Rs. 9/8/- per acre.

Importance of organic matter.—The Indian soils on the average are poorer in organic matter. The application of organic manures for maintaining the fertility of the soil cannot be over emphasised. From the above it is clear that the cotton crop does not appear to respond appreciably either to compost or farm yard manure but their residual effects are high. In groundnut cake the cultivator has a manure which maintains the fertility of the soil and yet can profitably increase the yield of the crop. Groundnut cake has become very cheap these days due to the lack of export to outside countries and the cultivators should take the fullest opportunity to have increased yields and yet increase the fertility level of their fields. It can be had at certain places at as low a price as Re. -/14/- per maund.

Summary and conclusions.—Results of the cotton manurial trials at the Government Experimental Farm, Akola conducted during the quinquennium 1935-40 are analysed. The following important conclusions emerge.

1. The need for the application of Nitrogen to increase the outturns is indicated.

2. The application of potash is not effective.

3. The application of phosphate in the presence of nitrogen increases the yield significantly.

4. The application of manure half at sowing and half at intensive flowering appears advantageous but the effect appears to be governed by the character of the rainfall following its application.

5. It is more advantageous to apply 2/3rd of nitrogen in the form of groundnut cake and 1/3rd in the form of ammonium sulphate instead of giving all the nitrogen in the form of cake.

6. Cotton does not respond very much to the application of farm yard manure or compost at the rate of 40 lbs. of nitrogen per acre.

7. The response to the application of 35 lbs. of nitrogen either singly as cake or in mixture with ammonium sulphate is proporticnately much higher in comparison with the responses secured by the application of smaller doses. The increase in yield is of the order of 59% when 35 lbs. of nitrogen is given, 2/3rd in the form of groundnut cake and 1/3rd in the form of ammonium sulphate.

8. Application of farm yard manure or compost either singly or in combination with ammonium sulphate is done at a loss even when cotton prices are of the order of Rs. 85/- per khandi of 784 lbs.

9. Application of ammonium sulphate alone also does not result in statistically significant gain even at higher rates of cotton and a low rate of Rs. 4/8/- per maund of fertiliser.

10. Even when cotton sells at Rs. 55/- it pays to manure it with 35 lbs. of nitrogen, 2/3rd being given in the form of groundnut cake and 1/3rd in the form of ammonium sulphate when groundnut cake sells at Rs. 1/8/- per maund and ammonium sulphate at Rs. 5/- per maund, the net profit secured being of the order of Rs. 3/6/- per acre.

11. If cotton sells at Rs. 75/- the profit secured at the above rates of the manures exceeds Rs. 8/- per acre, the extra investment required being about Rs. 9/8/- per acre.

12. Residual effects of the organic manures are noticeable on the subsequent crop of jowar.

I am indebted to S. S. Pande, Esquire, Economic Botanist for Cotton for making available the experimental data and to J. C. McDougall, Esq., C.I.E., Director of Agriculture, Nagpur for giving the necessary facilities.

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Examination Results 1941-42

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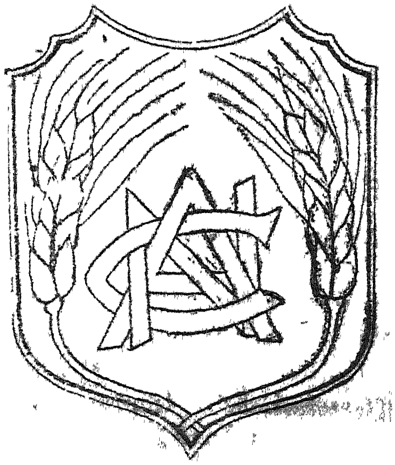

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The Nagpur

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Editorial

INDIAN TRADE IN AGRICULTURAL COMMODITIES DURING 1940-41*

The main feature of the period is the dislocation of the normal trading activities between different countries, due to the extension of the war over a number of countries, including the United States of America. Production, transport and the utilization of man power in the belligerent countries was therefore considerably affected. Introduction of various forms of control in production, import, export and consumption became necessary. The scarcity of some of the necessary commodities has been felt almost by every country.

Agricultural conditions.--Two opposite tendencies were notable. After the months of May and June in 1940, contrary to all expectations, prices recorded a sudden decline. The problem of low prices and unexportable surplus in jute, groundnuts, and sugarcane assumed an alarming proportion. The closure of the European Markets, the lack of shipping facilities and a fairly good outturn created this situation. The condition in the Far East caused considerable anxiety which led to a great decline in the price of short staple cotton by the end of July. "Between April and July, the index of wholesale prices of primary commodities (19 August 1939=100) dropped from 124 to 112. Great relief was felt when the prices resumed their upward trend from the beginning of August 1940. This was mainly due to the combination of various factors e. g. the increase in the export to the

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* "Review of the Trade of India in 1940-41."

United Kingdom, greater absorption of the raw material for domestic consumption and the confidence created by the special activities of the Central and the Provincial Governments in taking steps to help the primary producer."

The condition of the trade, prices and production of the chief agricultural products is discussed below.

Raw cotton.—In spite of the stimulus given by the war to the World's textile industries, the shrinkage of the international trade in cotton has resulted in accumulating large surpluses in the important cotton producing countries. Relief has been granted in America to the cotton growers there by means of granting loans on the year's carry over. Regarding the position in India, it is estimated that it may be generally characterized as unfavourable. "The crop was estimated at 5,785,000 bales which was 18 per cent higher than the preceding year. Great difficulty was found in disposing of the short staple varieties. Japan reduced her purchases of this cotton, while shipping difficulties came in the way of transport elsewhere. But the exports to China showed an increase. In spite of these discouraging features, the position was considerably improved owing to the great increase in the consumption by the Indian Mills, which is estimated to be 17 per cent higher during the seven months from September to March, as compared to the same period of the previous year. The government had to introduce special legislation which imposed import restrictions in order to avoid the accumulation of unexportable surplus.

Raw jute.—Owing to the large use of gunny bags during the war, it was expected that the jute industry would thrive well during the year. But contrary to all expectations the industry was required to undergo very severe trials.

"Over-production, a drastic lull in the export demand due to shipping difficulties, and the loss of European markets, continuous reduction in home consumption owing to the successive restrictions imposed on the out-put of jute manufactures and a series of earnest but only partially successful attempts made by the Government of Bengal to solve the problem created by such a serious mal-adjustment between demand and supply—were the conspicuous features of the raw jute situation during the year."

In spite of the previous warning by the Government in this year " the cultivators had actually sown a much larger area than in the previous season leading to a crop of 13.2 million bales, probably the largest ever grown." With the loss of the European market, which consumed nearly 56% of our jute in the previous year, the acute shortage of shipping, and the shrinkage of the local demand, stocks began to be accumulated. The prices fell by about 50%. The Bengal Government fixed the minimum price level in order to protect the cultivators from utter ruin. They also attempted to buy a part of the crop. Further, an agreement was made with the mill owners which stipulated that the latter should purchase jute above a specific level of prices. All these attempts were only partly successful, but, another agreement which clearly mentioned the purchases to be made by each mill at agreed prices up to specified amounts by specified dates, was comparatively more successful in stabilizing the prices. The decision of the Bengal Government to restrict the area under jute in 1941 by 2/3 of that sown in 1940 was most opportune and its declaration improved the prices at the commencement of the new year.

Groundnuts.—The cessation of trade with the continent, our chief market for oilseeds, which usually absorbed nearly three fourths of our normal exports, besides ten per cent increase in the production, resulted in lowering down the prices, even below the pre-war level. The year, therefore, recorded the lowest price of groundnut. In the latter part of the year the lower prices encouraged consumption in India and this helped the absorption of the crop. The special feature of the period is the assistance received from the United States which absorbed double the quantity when compared to the previous year. The price fixed for the purchases was also fairly remunerative. As the benefit of this high price could not reach the cultivator, it was arranged to receive a rebate from the shippers which formed a special fund. It was further decided to utilize this fund towards encouraging the consumption of the crop, partly by drawing attention to the use of groundnut oil as an illuminant, and partly by increasing the consumption of groundnut cake as cattle food and manure.

Linseed.—With regard to this crop, the year began with a very optimistic outlook. Export control was instituted in order to preserve the supply for the use of the Allies. But in the latter months it was found that such control was unnecessary as the general outlook of the trade did not keep to the expectation. Argentine, the chief supplier of linseed had a record production. In India, higher surplus from the last year was found to have come to the market, while the reduction in the acreage was only 5 per cent. The export controls were therefore relaxed. Though linseed prices declined owing to the emergence of the large Argentine suppliers, yet, on the whole, the position of linseed remained much better than other crops. The United Kingdom imported a higher quantity than the previous year and the internal consumption also increased. By March 1941 the linseed prices recovered to the extent of nearly 3 per cent above the previous prices.

Wheat.—" Wheat, which is a commodity of profound importance, presents situations of extraordinary differences during this period. The world's total supplies of wheat during 1939-40 season were the largest in history and the carry over to the next year remained at a higher level. The world production of wheat in 1940-41 season together with the carry over from the previous year made the world's supplies of wheat fairly high which resulted in fairly large surpluses being held by the major exporting countries. The shrinkage of the shipping trade and the complete loss of the European markets were also partly responsible. The price level therefore did not show particular promise." In India where only Australian wheat is imported, the prices remained fairly high owing to a bad crop in Australia and the difficulty of obtaining shipment. As the season progressed it was evident that the local supplies were falling short of the demand, with the consequence that prices of wheat began to soar up so much that by the end of November they reached nearly 72% above the pre-war level. The principal reason for this, apart from the reduction of the Australian imports, is supposed to be the opening of the new market of the Persian Gulf and Suez Ports and the expectation that large quantities of wheat would be purchased for the requirements of armies stationed in the Middle East. The year closed with prices showing a firm tone.

Rice.—The partial failure of the Indian crop in the year, estimated to be 15% less than the previous year, was mainly responsible for an upward trend in the price of rice through out the year. The difficulty of obtaining supplies from Burma came in the way of making up the deficiency. Later in the season, due to the special efforts of the Government, shipping was provided and the upward trend of the market was resisted, with the prices, remaining only 6% above the pre-war level. The exports from India showed a decline, with Ceylon however taking an increased share i. e. by 29 per cent than the previous year.

Tea.—The consumption of tea has increased during the war. In the United States and India the consumption of tea showed an increase over 20% than the previous year. The loss of the European market has not affected this industry as lately the export to these countries was considerably reduced, it being only 1% of India's total exports of tea in 1938-39. The British Ministry of Food had contracted for obtaining supplies of tea from India on a price, one penny per pound higher than the three years' average price, prior to the out-break of war. Provision was also made for re-exports which had the effect of guarding carefully the usual market. In 1940, the total production of tea in India was 463 million lbs. The prices during the year were fairly satisfactory.

Original Articles

VEGETABLE CULTIVATION IN THE CENTRAL PROVINCES AND BERAR

By Dhannalal, L. Ag.

(Lecturer, College of Agriculture, Nagpur)

The growing of vegetables is usually a very lucrative occupation for cultivators whose lands lie on the outskirts of large towns. It is also an interesting and at the same time a paying hobby for those who can maintain a small kitchen garden at the back of their houses or even in their yards. Recent studies in dietetics have elaborately described the great importance of vegetables as an article of food owing to their rich vitamin contents and other nutritive properties. The inclusion of larger quantities of vegetables in the dietary will be of great help in building up the health and strength of the population. The recent development of motor transport has considerably assisted in the development of vegetable cultivation in the districts which, while possessing the soil and climate eminently suited for the purpose, are now considered to be not too far off from the market they intend to feed.

It has frequently been observed that there is always a considerable demand for varied and wholesome vegetables in the local market but unfortunately the demand has never been properly met. On the other hand, the demand has increased considerably during the last few years due to war conditions and larger quantities of vegetables are urgently required to meet the requirements of the military in addition to those of the civil population. The pressing need of the hour therefore is an intensive propaganda for growing more vegetables and every means at our disposal has to be used to speed up its cultivation wherever possible and to impress upon the growers the urgency and the importance of the problem. Every land holder therefore, who has irrigation facilities should be appealed to in this hour of need to co-operate in this activity by allowing his land to be used for growing more vegetables. All the same, timely and strenuous efforts should be made to start intensive cultivation by which the yield of the vegetables may be increased considerably. The fact is that, while the art of production is developed in some degree or other by all the cultivators in general more especially the Kachhis, practically very little is known to them of the recent scientific methods of producing increased yields, growing of suitable varieties adapted to the conditions of any particular soil or climate, e. g. manuring with special fertilisers to suit a particular crop or a particular type of soil, etc. Considerable improvement may therefore be effected both in the yield and quality of the production, provided, modern and scientific methods of cultivations are adopted and developed.

The main object of this article is to acquaint those interested in this occupation with the scientific aspects involved and the practical methods to be adopted in the successful production of vegetables and their handling, whereby, the risks of failure may be considerably lessened and the prospects of success increased. An effort has also been made to incorporate the experience and the practical knowledge gained from the Kachhis who may be said to be the pioneers of vegetable growing in this province.

For the successful cultivation of vegetables it is necessary that the following points should always be borne in mind, viz.

1. The site for each crop should be suitable for its easy disposal.
2. The soil should be in good condition i. e. properly cultivated.
3. The seed should be sown at the right time and in the right way i. e. at proper depth.
4. The plants should be allowed ample space for growth.
5. Other processes such as hoeing, weeding, irrigation and protection of the crop from pests and diseases, etc. should be attended to.

Matters relating to cultivation of vegetables in general are dealt with in the earlier portions, while the particulars have been given along with the description of the vegetables concerned in their proper places.

The main factors responsible for the successful production of vegetables are given below :—

Soil and its preparation.—The soil best suited to the successful cultivation of most of the garden crops is one with an abundance of humus and a good supply of water nearby. It has been said figuratively that the soil is the skeleton, humus the flesh and bacteria the blood, so that if any of these are lacking the fertility of the soil tends to be low. Ordinarily, a sandy loam is considered to be the best soil for this purpose, but no one type is suitable for all crops under all conditions. Every kind of soil has its advantages and disadvantages. The soils utilised for vegetable production are generally deep sandy loam and clay loam, and should be well drained. Good drainage is essential to success as it removes the excess water and allows the air necessary for soil organisms to enter into the soil.

Thorough preparation of the soil is an important factor for the successful production of all crops and especially so in the growing of vegetables. The soil for vegetables should be ploughed deeply by means of improved ploughs and bukhered several times to obtain a fine tilth. If the land is cloddy or uneven, a clod crusher or leveller, should be used. The thoroughness with which the soil is prepared before planting determines to a considerable extent the character of the crop that can be raised from it. It is also essential to perform these operations at the proper time.

Manurial requirements.—In order to maintain the soil fertility in an effective manner, frequent applications of manure are necessary. Cropping on an exhausted soil often results in low yield and also in a lower food value of the crop. Since fertility is not always a constant quantity in the soil it has to be renovated after a particularly exhaustive crop is taken off, and the cultivator has to take care to grow such crops as possess the double feature of their saleability in the market and their suitability to the conditions of the soil.

In the early days farm yard manure was practically the only fertilizing material applied to the soil. It is still the chief resource of the market gardeners for maintaining the productiveness of the land. Due to the increased acreage under vegetables during the last few years, the supply of manure has proved to be too inadequate to meet the needs of even the ordinary growers of vegetables, Hence considerable discretion should be used in the care and economic use of manure available. Where farm yard manure is difficult to obtain or becomes too expensive, an excellent substitute, both for heavy and light soils, is to be found in green manuring. Sunnhemp for this purpose is generally grown until the flowering stage appears and then ploughed in. This method of manuring has the advantage of adding organic matter to the soil in addition to replacing to a considerable extent the available plant food materials which the previous crop has drawn from the soil.

Oil cakes also form an important item in the manuring of crops, being so cheap and at the same time so easily available in the market. The vast extension of area under the groundnut crop more recently has made available large quantities of this cake which is only used for feeding the cattle or for manuring purposes. Other cakes such as those from linseed, castor, tilly, cotton seed etc. are also used according to their availability on the local market.

When fertilizers or artificial manures are applied in dry form, they should be mixed with fine dry soil or sand and spread evenly at the specified rates. The best vegetables are grown only when a moderate dressing of farm yard manure or cake is supplemented by a good dose of a suitable fertilizer containing nitrogen, phosphoric acid or potash according to the requirements of the particular crop. Nitrate of soda and sulphate of ammonia are the best fertilizers for the supply of nitrogen. Phosphate can be provided in the form of superphosphate of lime, bone meal, basic slag, niciphos grade I and II, while potash can be supplied in the form of sulphate of potash.

Seed.—The most important factor in vegetable growing is the question of supply of good seed. Since seed growing is a highly specialized business requiring considerable knowledge and skill, it is always safer to buy seeds from a good and reliable seed firm. Such seeds can be depended upon to germinate properly and the seedlings obtained are generally healthy. It is a false economy to buy cheaper seeds as it often causes much disappointment. The choice of varieties largely depends on local conditions. It is however useful to grow several kinds in the beginning and to select afterwards the variety that does the best. The depth at which the seed is sown depends on the condition of the soil, the size and the type of seed sown and the time of the year. When the soil is moist, the sowing should be shallower than when it is comparatively dry. Very small seeds should be barely covered, whilst large seeds such as peas or beans should be put in 1″ to 3″ deep according to circumstances. The quantity of seed to be sown, the distance between plants, as well as that between the rows will be found in the notes describing the various garden crops in detail.

Nursery.—This is the name given to the specially prepared seed-bed in which seeds are sown in bulk, seedlings raised and reared till such time as enables them to be transplanted separately to their permanent places. The principal function of a nursery is to raise and grow plants which are not sturdy enough to be planted directly into a garden or plantation. This method provides a good home for the seedlings to develop as they are usually sown on raised seed-bed and are regularly irrigated. The method of preparing a nursery is as follows:—

The site for nursery should be selected on a high level but close to the source of water supply. It is better to burn the area once to destroy all insect and fungoid pests that may have infested the land. As it is absolutely necessary for success that a fine tilth should be provided for the seed bed, the land should be well cultivated and properly pulverised by subsequent operations to produce the requisite condition for sowing. It should then be manured at the rate of 40 cart loads of farm yard manure per acre. The manure should be evenly spread and thoroughly mixed with the soil. Raised beds 6″-9″ high are then prepared 4′ apart from centre to centre and of any convenient length. The top of the bed is about 2½′ wide and the remaining space of 18″ is used up for making water channels. Seeds are sown on the top of the beds in lines 3″ or 4″ apart and are afterwards covered by pressing the hand lightly over them. The beds should be watered immediately by a watering can. Light waterings should be given morning and evening for a few days until the seeds germinate. If watering is done carelessly the soil will be washed out and the seeds exposed. It is therefore better to spread some grass in a thin layer over the bed before watering. It should however, be removed after the seeds have germinated. Subsequent waterings should be given through the furrows at intervals of 4 to 6 days according to season. Shades should be provided to all sowings for a few hours during the hottest part of the day and during the rainy period.

Beds should be kept free from weeds and stirred after each irrigation. If there is an insect attack spraying, dusting or hand-picking should be resorted to immediately to check the trouble. When the seedlings are in 4 to 6 leaved stage, they should be transplanted. The beds should be watered a day previous to the uprooting in order to facilitate the removal of the seedlings. The best way to take out the seedlings is to use the fork and lift up the plants along with the soil. This should be done either on a cloudy day or at evening time. The area required for growing seedlings in a nursery for different crops varies considerably. For chillies, brinjals, tomatoes, cabbages and cauliflowers about 300 sq. ft. of land would be sufficient while for onions about 500 sq. ft. would be necessary.

Layout.—The land after having been properly cultivated is given the requisite quantity of manure or fertilizer and is then laid out in beds or ridges and furrows by means of an E. T. plough or a country plough as the case may be according to the system of irrigation required and the lay of the land. A most useful form of layout is to run the channels down the highest piece of land and run the ridges and furrows about 10′ long at right angles to the channels.

Irrigation.—This is the most important factor in the management of a vegetable garden. In the Central Provinces, it is almost impossible to grow vegetables without an artificial supply of water, be it a well, a tank or a canal. When the latter sources of supply are not available, the well is the only practicable means of obtaining the supply.

Various contrivances have been devised from time to time for lifting water from a lower level, but for tanks or wells where the water level is about 20′ ft. from the surface, "Persian wheel" or "Rahat" is probably the most effective appliance at present in existence. In cases of deep wells, however, "mhote" has been found to be the most efficient lift, worked by one man and a pair of bullocks.

There are 3 methods by which water is usually applied to the crop.

(i) Flooding,
(ii) Furrow irrigation,
(iii) Hand watering.

(i) **Flooding.**—In this system water is delivered at one spot and is allowed to spread itself by the force of gravity in the form of a layer on the surface of the soil. This layer may be stationary or may be moving. The speed of the water must not be allowed to become too great or else the land will suffer from erosion.

(ii) **Furrow irrigation.**—In this system water is not spread over the whole area in the form of thin layer, but is allowed only to run in furrows from which it is soaked in all directions and is supplied to the plants growing in the spaces in between.

(iii) **Hand watering.**—Irrigation by sprinkling or pouring :—

In this method the water is brought in cans and poured down to the beds in which the seedlings are growing.

This is probably useful though not a very satisfactory method. It cannot be used on a large scale as the cost of hand labour would be prohibitative and the loss from evaporation is proportionately greater.

Weeding and thinning.—One of the secrets of success in growing garden crops of good quality is an efficient and deep cultivation to start with and continuous surface cultivation when the crop is on. If successful results are to be obtained the hoes and hand tools like khurpies, blued hand forks must be kept in constant use. As soon as the seedlings appear through the soil, weeding must be started and the stirring of the surface soil should be repeated at frequent intervals, more especially after each irrigation. At the time of thinning, the weakest of the plants should be removed while the more vigorous ones allowed to remain. Thinning is necesssary in order that the plants may have sufficient room to develop. They thus get sufficient light and air, and have adequate space for the expansion of their root system, which enables them to obtain more moisture and plant food than they would otherwise do.

Rotation.—A definite rotation of crops, as is usually recommended in cases of field crops, cannot be strictly followed by the vegetable growers, who have to produce a large number of crops in constant succession on a small area. In such cases, the most carefully planned scheme is liable to dislocation by unsuitable weather, attack of insect pests and other unforseen circumstances which may make it necessary at short notice to discard one crop and substitute another of an entirely different kind.

However, a deeply worked and well manured soil will yield good crops in any season, even if a regular rotation system is not strictly followed. It must be remembered, however, that almost all vegetable crops require a change of soil as often as possible and wherever practicable they should never be made to occupy the same place in successive years.

Intensive cultivation.—In the cultivation of garden crops, it should be the aim of farmers to keep all available land under some crop or other during the growing season; and this means sowing or planting again as soon as one crop is lifted. Often this can be improved upon and vegetables that mature quickly can be sown or planted between those that take longer time to mature. This is known as inter-cropping and should be practised whenever possible. It should be clearly understood, however, that this means a heavy drain on the fertility ingredients of the soil. Systematic addition of fertilizers therefore becomes an imperative necessity if the full vigour of the crop is to be maintained. Nitrogen is the element which soon gets exhausted and must be replaced. A periodical dressing of farm yard manure is very useful in maintaining the fertility of the soil.

Insect pests and diseases.—When adverse weather conditions operate injuriously on vegetable crops, the pests that usually infest these acquire increased vigour in proportion to the degree of debility to which the vegetables are reduced. Excessive moist conditions which so often jeopardise vegetable growth are usually followed by such diseases as mildew, mosaic, virus, etc. along with the visitations of flies and maggots. Spraying, dusting, timely cultivation and other control measures will often prevent the vigorous attacks of the various insect pests against which a vegetable grower has to fight an unceasing battle.

SCOPE FOR THE EXTENSION OF THE CULTIVATION OF POTATOES IN THE CENTRAL PROVINCES AND BERAR

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Introduction.—The "Grow more food campaign" opens a new vista for the expansion of potato cultivation in the Central Provinces and Berar. Though said to be of recent introduction, the potato has gained an immense importance as an article of food, as a commodity of commerce and as a vital basic material for a number of industrial purposes.

After wheat and rice, potato may be regarded as an important food material. This importance is brought out by the fact that the annual production of potatoes in the world is 6,010 million maunds which is twice as much as the production of wheat and thrice as much as that of rice. Out of this 26.7% is produced in U. S. S. Russia, 20 9% in Germany, and 15.0% in Poland. India produces only 0.8% of this. Central Provinces produces 325,000 maunds annually.

The total area occupied by this crop is over 50,620 thousand acres in the world. The position of India in the world acreage is the eighth, having 449,000 acres only. This means 0.9% of the total world area. The other important potato growing countries are U. S. S. R., 33,3%; Germany, 13.9%; Poland, 13.9; France, 6.9%; U. S. A., 6.6%; Czechoslovakia, 3.7%; Italy 2.0%; U. K. 1.5%. The area under this crop in this province is 3,400 acres.

The volume of trade it occupies can be imagined from the fact that 31,572,000 maunds of potatoes are imported and 33,949,000 maunds of it are exported annually from the different European countries. India is only an importing country, importing potatoes valued at Rs. 33,18,706 annually. Central Provinces import 1,56,500 maunds of potatoes from other provinces.

Industrial importance.—Potato is grown in India for table purposes only. Its industrial possibilities have not yet been exploited on account of insufficient supply. In other countries like Germany, Czechoslovakia, Poland, etc., potatoes are utilised for stock feeding as well as for a number of industrial uses. Some important products of potatoes are (1) Farina or potato starch used in laundry, sizing yarns and preparation of pastry and confectionaries. The value of farina and potato flour imported annually into India is Rs. 6,72,989. (2) Dried potatotes are of immense importance during the war time. (3) Power alcohol can be extracted from rejected tubers. (4) Dextrin and glucose are also valuable products obtained from the potato.

Thus from both agricultural and industrial points of view, the potato crop needs a greater attention. There is a great scope for the extension of the cultivation of potatoes in the Central Provinces. The annual per capita consumption of potatoes is 8.6 lbs. for the whole of India whereas it is 140 lbs. in America and 440 lbs. in Germany where potatoes are used for industrial purposes also. The per capita consumption of potatoes in the Central Provinces is only 2 lbs. which is a very low figure when compared to those of other provinces e. g. 28 lbs in the United Provinces, 16 lbs. in Bihar and 13 lbs. in Sindh. If it is raised to 28 lbs. we will have to produce 54,27,400 mds. of potatoes annually in this province. This will require

57,130 acres of land taking 95 mds. of tubers as an average yield from an acre.

The area under this crop in this province was estimated to be 2,500 acres in 1930-31. It gradually rose to 3,700 acres in 1935-36 and was 3,500 in 1938-39. The annual production of potatoes in this province is estimated at 3,25,000 mds. About 1,56,500 mds. of potatoes are annually imported into this province from the neighbouring provinces. The total quantity of potatoes thus available in the province is 4,81,000 mds. It has to be borne in mind that out of 3,25,000 mds. of potatoes produced, 7,000 mds. (2.2%) are retained for village consumption and 1,700 mds. (0.5%) are retained for seed purposes by the growers. The total seed required per annum in the province is about 37,000 mds. Out of this 90% is imported from other provinces.

It is thus imperative to augment the area under the crop in this province in order to increase the production and per capita consumption. Thus there is a scope for the extension of this crop over 53,431 acres more in this province. But the actual expansion of this crop will depend upon a number of factors discussed below.

(1) **The soil conditions.**—The best soil for growing potatoes in India is the deep alluvial soil of the Gangestic plains. The essential requirements of potato soils are non-stickiness, looseness and depth with plenty of humus. These conditions are obtained in soils of medium texture originating from silt deposits or *in situ* formation of the residual or cumulose types. Clay in larger percentages always causes stickiness in soils which is detrimental to the formation of good sized and well shaped tubers. Any deficiency of organic matter as found in residual soils subject to leaching, or in new formations of soils on hill sides will depress the yield of tubers. Such deficiencies should be supplemented by an addition of a good dose of well decayed farm yard manure. A soil possessing rich store of humus and medium texture will not require much attention about drainage of superavailable water in it.

The soil conditions of this province are suitable in the northern districts of Jubbulpore, Hoshangabad, Nimar, Saugor, Chhindwara, Betul and Mandla. The sandy loam soils of the type of *Sehra* or *Sehar* found in these districts are well suited for the cultivation of potatoes. The *wardi* soils of Chanda, the *matassi* and *dorasa* soils of Chattisgarh are also suitable for its cultivation, under skilful management. The *Morand* II soils of light black colour with plenty of grit and lime may be utilized for growing potatoes in the cotton districts, if water and manure can be supplied in sufficient quantities. The red and brown soils on the hills of the Satpura system and the Melghat tract have also been found to grow good crops of potatoes during the monsoons.

(2) **The meteorological factors :—**

(a) **The atmospheric temperature.**—The prevailing atmospheric temperature plays a great part in the development of a crop. The mean temperature of a place gives an idea whether the potatoes can be grown successfully or not. The atmospheric temperature should not fall below the freezing point during the life time of the crop as it is susceptible to frost-bites. The temperature should not rise much higher than 75°F during the growing period of the crop, otherwise, the crop is brought to a premature ripening, depressing the yield to an uneconomic extent. The optimum atmospheric temperature during its growing period ranges between 42°F to 75°F.

(b) **The rainfall.**—A heavy precipitation during its growth on plains is not conducive to its successful cultivation. Any rainfall between the planting of tubers and their germination is harmful, as is also the case with an irrigation before germination. It is due to the lowering of the soil temperature by the addition of cold water which results in the retardation of the process of germination. During the period of tuber formation also the rains may affect the crop in the same way by impeding tuber formation and depressing the outturn. It is for this reason that the well water which is warmer than the river or canal water is preferred by the potato cultivators in this province for purposes of irrigating this crop. The potato crop thrives well when the average monthly rainfall is below 1″ during the potato season i. e. from October to March on the plains.

On the hills, however, the rain water is not so unfavourable as the growing period of potatoes falls within the Summer months from June to September. After the scorching heat of the sun, the first showers in June, the planting time of potatoes on hills, do not lower the soil temperature to an extent which may be adverse to germination. The subsequent rains on hills also do not produce a chilling effect on the soil as would be the case during occasional showers in winter. The soils on hills are generally porous and well drained and do not produce water logging conditions during the monsoons. This is why the potatoes can withstand heavier rains on the hills.

(c) **The humidity.**—The atmospheric saturation plays an important part in the life of the crop, but is always regulated by artificial irrigation under which this crop is generally grown. The optimum humidity may lie between 55% to 56% of air saturation. If it is lower than 55% the potato crop needs greater frequency of irrigation to prevent the scorching of the leaves.

(d) **The visibility of the sun.**—The sun shine is very important for all crops of this nature. A cloudy weather is always harmful in not only depressing the physiological activities of starch synthesis, but also in encouraging the attack of insects and other pests. The occurance of "Parrya" and "Tamlaya" diseases has been noted during the cloudy weather.

(e) **The climatic factors of the Central Provinces when compared with those of the potato centres of India—The United Provinces and Bihar.**—The climatic conditions of this province are in no way less favourable to a successful husbanding of this crop than in the famous potato growing provinces of the United Provinces and Bihar. To explain this I reproduce the meteorological records of the important potato centres of the U. P. and Bihar along with those of the C. P. in Appendices A. & B.

The Range of Mean Temperature in the Potato Season
(in degrees Fahrenheit)

Province	September	October	November	December	January	February	March	The range during the potato growing period
U. P. & Bihar	83—85	76—80	65—72	58—64	57—64	62—69	73—81	60—75
C. P.	76—80	73—79	60—77	61—71	62—68	66—73	76—82	60—75

The mean temperature during the potato growing season in U. P. and Bihar ranges between 60°—75° which is obtainable during the months of November to middle of March while a corresponding period in the Central Provinces lies between middle of October and February. The planting of potatoes may, therefore, start a fortnight earlier in this province and its lifting may finish by a month in advance when compared to the two premier potato provinces. The temperature conditions are thus not less favourable in this province than in U. P. and Bihar.

The Range of Mean Humidity during the Potato Season

Province		Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March
U. P. & Bihar	...	67—83 (16)	48—77 (29)	43—69 (26)	53—75 (22)	54—71 (17)	45—63 (18)	37—54 (17)
C. P.	...	79—75 (4)	55—67 (12)	42—59 (17)	45—58 (13)	46—59 (13)	36—50 (14)	28—40 (12)

The atmospheric humidity in Bihar and U. P. is higher having greater variation during the months of September to March. This is due to the fact that the alluvial soils of these provinces are hundreds of feet in depth which store nearly all the rain water which has sunk into the ground. This water rises up by capillarity after the monsoons and supports a number of unirrigated crops and weeds. The transpiration from such vegetation and the evaporation from the surface of the soil and numerous rivers cause a higher saturation of the atmosphere in these parts of India during the winter and summer. It is on this score that potatoes of long duration or late varieties of four months even, are successfully grown there.

In spite of the comparatively larger areas under forests in the Central Provinces, the humidity in the cultivated areas of the province is lower on account of the shallow nature of the soil, where much of the rain water is lost by run off or seepage into the *nallahs* and streams. After the rains are over, not much ground water is available in the soil which may support crops without irrigation during the winter. The general humidity is consequently lowered. A larger number of irrigation is, therefore, needed for the potato crop to supply the necessary quantity of water to the plants and to maintain, to a certain extent, a favourable humidity in the crop area.

The rain fall of this province is nearly as favourable to the potato crop as in Bihar or U. P. The month of September is slightly wetter in this province. It is for this reason that plantings in this month are not quite successful in respect of the yield from an acre. The effect of the rainfall at the time of planting is to depress and delay germination, while at the time of tuber setting also it retards the growth of tubers in the soil.

Though early sowings are not quite successful yet the loss in its yield is compensated by the high prices obtained in December when the demand is high, as this is not the general harvesting time for this crop in India. After the month of July (on hills) to January (on plains) whenever the monsoons are scanty or favourable, it is always profitable to plant potatoes early. There is a practice of planting potatoes in the month of early July on hill sides above 2,500 feet near Chhindwara towards the Pachmarhi direction. The yield of this crop is depressed by half on account of the rains, but the price obtained compensates the loss.

However the best time for general planting on a large scale starts from the middle of October, when the rains cease and it lasts up to the end of November. The winter rainfall conditions in this province are quite similar to those obtaining in Bihar and U. P. The tuber setting period viz., the months of January and February, is as free from rains as in the other two provinces. (*To be continued*).

THE INHERITANCE OF AWN AND GLUME COLOURS IN WHEAT

By Ravi Shankar Shrivastava, L. Ag.

Introduction.—The awns of wheat are either white, red, or black, the tint of colour varying in each group :—the white colour varies from pale white to yellow, red varies from light red to deep red brown and black from light sooty to deep black. The white and red colours are uniformly distributed throughout the length of the awns while the black colour is restricted to only the lower parts, the upper is either white or red according to the colour of the glumes with which it is correlated. A large number of varieties having red or white awns are indigenous to the Central Provinces and Berar while the black awned varieties are only three viz, Bansi, Bangasia and Khapli, (Evans 1908).

In respect of the grain colour, wheats are divided into two classes white and red. In the latter a reddish or brownish substance is present in the testa of the seed while it is absent from the seed coat of the white grain. Flour of wheat is used in this country in the form of whole grain meal and the testa of the grains imparts a brownish appearance to it. Therefore the red grained wheats are sold in the local markets at a discount and hence they are not popular, but they are very hardy and drought-resistant therefore they are grown only on inferior types of soil where white grained wheats are not cultivated successfully.

A few purple grained wheats also occur and they are restricted to Abyssinia. Percival (1921) has described one or two purple grained varieties which he obtained from that country. The purple colour is due to anthocyan pigment present in the upper layers of cells of the seed coat.

Previous reference.—Genetical investigations with respect to both red awn and red grain colours were carried by a number of investigators (1905, 1913) but very little work on inheritance of black awn and purple grain characters has been reported to have been done.

Biffen (1905) found in F 1 generation of a cross between red and white grained wheats all kernals red and F 2 segregated in ratio of 3 red : 1 white.

Howard and Howard (1913) found evidence of existence of single factor difference for black awn colour and double factors for red grain colour in forms of *T. Vulgare* and three factors in American Club *T. compactum*.

Percival (1921) reports that heredity of awn colour agrees with that of glume colour. Black and red awns are dominant to white, and black to red. As regards inheritance of grain colour, he cites a case where three factors are found for the red grain colour which has been designated $R_1 R_1$, $R_2 R_2$, and $R_3 R_3$. "From the hybrid Svalof 'PUDEL' (white chaff and white grained square head) X Swedish 'SAMMET' he obtained in F 1 plants with pale red coloured grains. All the grains of the F 2 generation were also red with several shades. On raising F 3 generation from one of these hybrids he found some plants segregate in a ratio approximate to F3 red : 1 white, others gave a progeny of 15 red : 1 white while a small number exhibited trilybrid ratio approximate to 63 red : 1 white."

Inheritance of purple grain colour has heen reported by Capron (c. f. Percival 1921). It is reported, " Capron studied inheritance of purple tint in a cross, made originally by Biffen, between *T. polonicum* with white translucent grain and purple grained Abyssinian wheat Eloboni (*T. dicoccum, Var Arreiscita*). The F 1 grains were uniformly purple. In the F 2 were found (1) fully tinted or flushed grain of light or dark shade, (2) grain with longitudinal streaks of purple, (3) uncoloured grain, proportion approximate to a ratio of 3 fully tinted or flushed : 1 grain with longitudinal streaks : 12 uncoloured."

Steward (1926) reports three factors difference for the red grain colour in a cross Kanred X Sevier. The F 2 progeny segregated in a ratio approximate to 63 red : 1 white.

Kadam and Nazarath 1931 reported inheritance of awn colour in a cross Kala Khapli X red awned Bansi. A ratio of 12 black : 3 red : 1 white is obtained in F 2. The genetic interpretation of the results is made cn basis of two pairs of factors *B B* and *R R*.

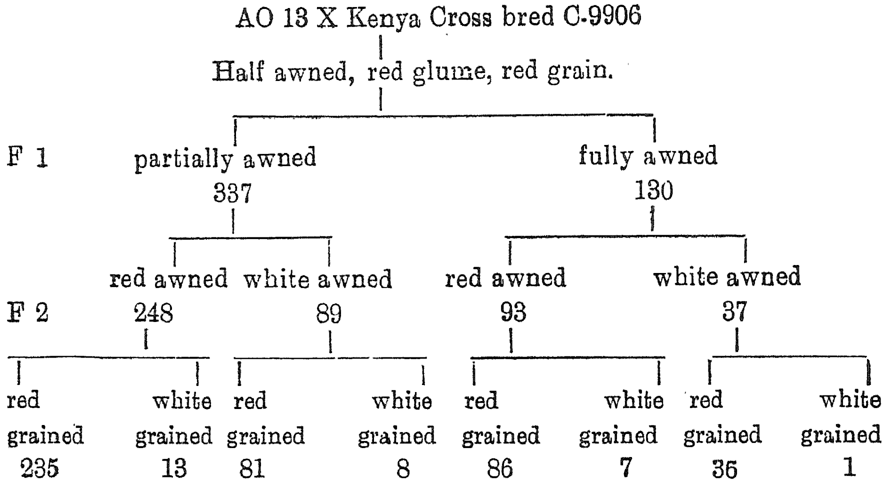
Observations.—Cross I, AO 13 X Kenya Cross Bred C 9906.

AO 13-a fully awned wheat having white awns, pale white smooth glumes, soft white grains.

Kenya cross bred C-9906 an awnletted variety (e. i.) almost every spikelet bears short awns about 1 c. m. long, glumes smooth deep red, grain red. The cross was made in the year 1937-38.

The F 1 plants were found to possess awns about 3 to 4 c. m. long; awns red ; glumes light red, smooth ; grain light red.

F 2 progeny segregated in respect of *awnness*, colour of awns, glumes and grain. Segregation is shown below.



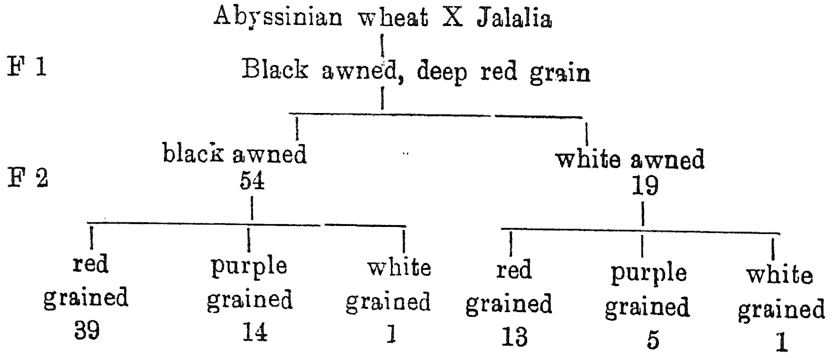
Cross 2, Abyssinian wheat X Jalalia

Abyssinian wheat—ear fully awned, awns sooty black, glumes sooty black colour over white back-ground, smooth, grain purple.

Jalalia—ear awned, awns white, glumes pale yellow, smooth, grain white. The crosses were made in the year 1938—39.

The F 1 plants were found to possess black awns, glumes sooty black on white back-ground, smooth, grain deep red brown, at times patches of purple colour are observed.

The F 2 progeny segregated in respect of awn and grain colour. Segregation is shown below.



Cross 3, Khapli X Hansia

Khapli—Awns black below, red above, glumes hairy white, grain red hard.

Hansia—awns red, glumes red smooth, grain white hard, The F 1 plants were found to possess black awns, red hairy glumes, grain red hard.

The F 2 progeny segregated in awn and grain colour. The segregation in the F 2 of the cross is shown below.

The cross was made in the year 1932-33.

Khapli X Hansia

F 1 Black awns, red hairy glumes, red grain.

F 2	black awned 250		red awned 54		white awned 21	
	red grained	white grained	red grained	white grained	red grained	white grained
	236	14	52	2	19	2

Cross 4, Bansi X No. 58

Bansi—awns black below, white above, glumes white hairy, grain white hard.

No. 58—awns black below, red above, glumes red with sooty black colour over them, smooth; grain white hard.

The F 1 plants were found to possess black awns, red hairy glumes, white hard grain.

The F 2 progeny segregated in awn colour and hairiness of glumes

The F 2 population consisted of 774 plants with black awns, hairy glumes, 48 with red awns smooth glumes, and 14 with white awns smooth glumes.

The cross was made in the year 1932—33.

Crosses 5 and 6, Red pissi X I.P. 4; Kathia X No. 58

Red pissi—awns white, glumes smooth, grain red.

Kathia—awns white, glumes smooth, grain red.

I. P. 4.—awnless, glumes hairy, grain white.

The F 1 plants were found to possess red grains, the F 2 progeny segregated in red and white grained plants. The population consisted of 437 plants with red grains and 30 with white. The crosses were made in the year 1932—33.

(To be continued)

CULTIVATION OF CASTOR (RICINUS COMMUNIS)

By Dhannalal, L. Ag.

Castor forms one of the chief oil seeds in which the Central Provinces possesses a predominent share in cultivation and production. Numerous applications of the seeds, oil and oil cakes in the industrial, agricultural and domestic uses of mankind have stimulated an international trade in this seed. The well known medicinal oil is derived chiefly from the small seeded variety and the oil for lighting and other purposes from the big seeded one.

Varieties.—There are perennial and annual varieties of this plant. The annual varieties are very much smaller than the perennial varieties. The perennial varieties grow with great rapidity and a year's growth produces a tree 10' to 15' high. It can remain in the field for about 6 years or even more, but yields well continuously for 3 years only, hence it is resown after 3 years. It is often planted in the odd pieces of lands 'baries' near houses, along the irrigation channels, on the borders of sugarcane fields or other cultivated garden crops. As these are easily cultivated they incur less cost of production.

Season and climate.—Castor oil plant is grown both in the kharif and in the rabi season. As a kharif crop, it is planted between March and June under irrigation or at the end of June and early in July along with other Kharif crops. The rabi varieties are grown in October. In some places like Chanda and Bhandara the rabi varieties are sown mixed with wheat.

Soil.—Castor is a very hardy, deep rooted plant and once established it grows well even on light soils. Hence the plant does best in deep free working soils. It is not economical to grow it in deep rich soils where cotton, wheat, gram and juar are grown more profitably.

Kharif varieties do well on light soils and sandy loams, while the rabi varieties on morand and deep retentive black soil.

Rotation and Mixture.—Castor plant is a gross feeder and highly exhausting to the soil. Manuring therefore, will benefit the crop greatly. As sufficient quantity of farm yard manure is not available, the crop is not grown continuously on the same land. It is rotated with pulses and cereals. It is generally grown as a single crop but at times it is grown mixed with sugarcane, ginger and chillies.

Cultivation.—The land is made ready for sowing by the end of June or by the 1st week of July at the latest. Preparatory tillage is begun in hot weather by bukhering the land twice or thrice. It is sown during the last week of June when the monsoons break.

Method of sowing.—In the Northern districts castor is sown broad-cast at the rate of 15 to 20 lbs. of seeds per acre. The sowing is followed by light bukhering or shallow ploughing with country plough, for the purpose of covering the seed to a depth of 1½'. In Southern districts the seed is sown at a distance of 6' apart in line by means of bukher to which a Sarta is attached and the sower drops the seed 3' apart. The superfluous plants are thinned out at the time of weeding and hoeing. Seeds germinate after about 8 to 10 days, and when the young plants are a few inches high, the space between the rows should be intercultured by hoeing implements. Weeding and hoeing are done till the plants grow and cover the space rapidly.

As a rabi crop it is sown in the month of September or October on a well cultivated field by a Nari plough 18' apart row to row and a distance of 12' is maintained between plant to plant. About 12 to 15 lbs. of seed is required per acre.

Harvesting.—Harvesting begins as soon as the first fruits ripen. Kharif crop is generally ready for harvest in November and December, and the rabi in February and March. The bunches of the Capsules are cut as they ripen and are then spread thinly on the threshing floor for a week or so in the sun and air to dry, turning them over when necessary. The seed is separated by beating with a stick. The threshed material should be winnowed by a sup or winnower as in the case of other crops.

Yield.—The average outturn per acre under normal conditions comes to about 500 lbs. per acre, which gives 40% oil and is sold at 30 lbs. per rupee, the value of which is about 20 rupees.

COST OF CULTIVATION

Kharif Castor

1.	2 Bukherings	1	2	0
2.	Cost of seed	0	12	9
3.	Sowing charges	0	12	0
4.	Weeding, 8 female coolies	1	0	0
5.	2 Hoeings	0	10	0
6.	Collecting seeds 6 women	0	12	0
7.	Threshing and winnowing	0	7	0
8.	Land revenue	1	8	0
9.	Watching charges proportionate	1	8	0
	Total...	8	7	9

Cost of 500 lbs. of produce	Rs.	20	10	8
Hence the net profit	Rs.	12	2	11

Rabi Castor

1.	6 Bukherings	3	6	0
2.	Cost of seed...	1	0	0
3.	Sowing charges	0	11	0
4.	Harvesting charges	0	12	0
5.	Threshing and winnowing	0	7	0
6.	Cutting and removing of plants	0	6	0
7.	Land revenue	1	0	0
8.	Watching charges proportionate	1	8	0
	Total...	9	2	0
	Amount realised by the sale of the crop ...	18	12	0
	Net profit...	9	10	0

Perennial Type

I YEAR

(1)	2 Bukherings	1	2	0
(2)	Cost of seed	0	5	0
(3)	Charges for lines by Bukher	0	4	6
(4)	Dibbling seeds	0	4	0
(5)	One weeding and one hoeing	1	9	0
(6)	Collecting seeds	0	4	0
(7)	Land revenue	1	0	0
	Total...	4	12	6

II YEAR

(8)	2 Hoeings	1	2	0
(9)	1 Weeding...	0	12	0
(10)	Collecting seed	0	4	0
(11)	Land revenue	1	0	0
	Total...	3	2	0

Average expenditure for 6 years	Rs.	A.	P.	Yield
I year ...	4	12	6	500 lbs.
II year ...	3	2	0	650 ,,
III year ...	3	2	0	700 ,,
IV year ...	3	2	0	600 ,,

V year ...	3	2	0	400 lbs.
VI year ...	3	2	0	250 ,,
Total...	20	6	6	3,000 lbs.
Therefore for one year ...	3	6	5	516 lbs.
Amount realised by the sale of the crop	16	2	0	
Hence the net profit is	12	11	7	

A PRELIMINARY STUDY OF THE EFFECTS OF MULCHES ON THE EVAPORATION OF WATER FROM SOIL COLUMNS

By M. N. Paithankar, (III Year)

(An experiment performed in the Soil Physics Laboratory)

It is a well known fact that evaporation of soil water takes place almost entirely at the surface freely exposed to the atmosphere. Evaporation from soil surface implies not only unnecessary loss of water that should have remained for the use of the crop but also the depression of the temperature which is, as a rule, unfavourable to the best development of vegetation. The amount of water evaporating either from water surface or from a wet or moist soil, varies greatly according to the climatic conditions and the state of the weather, also according to the condition of the soil surface. Investigations indicate that about 70% of the precipitation on the land surface is derived from evaporation from land surface. Even in humid region where the annual rainfall is ample for maximum crop production, the crops are frequently reduced below the profit point by prolonged periods of dry weather in the growing season, during which the loss of water from plants coupled with the loss from soil, exhausts the moisture supply.

Paramount attention should therefore be directed towards the checking of loss by evaporation since the moisture thus saved means just that amount being added to the water available for crop use. An experiment was therefore undertaken to investigate into the matter.

Procedure.—Evaporimeters with a trough of water at the bottom of each of these were chosen and used in the study of :—

(i) The loss of water by evaporation from surface,

(ii) Effect of mulches on evaporation.

Soil was filled in the tube of the evaporimeters and water was poured in the troughs. The perforated bottom of evaporimeters was in contact with water in a close fitting reservoir. Water came up by Capillarity and when it came to the surface the evaporimeters were ready for the experiment. Three different soils, Morand, Silt and Bardi were used to fill the evaporimeters. The evaporimeters thus prepared were given the following treatments:—

No.	Height of Soil Columns	Soil	Treatments
1.	15″	Morand	Control
2.	15″	"	½″ soil mulch
3.	15″	"	1″ "
4.	15″	"	½″ saw dust mulch
5.	15″	"	1″ "
6.	30″	"	Control
7.	15″	Silt	"
8.	15″	Bardi	"

After giving the necessary treatments they were kept in shed for 10 days and weighed again. Then they were put in open and weighed at certain intervals, replenished with water and weighed again. Thus the experiment was continued for a number of days.

The results are entered in the following tables.

Table 1.—Observations taken at different intervals

Evaporimeters No.	Internal diameter	Area exposed to evaporation in sq. inches	Loss in gms. per day by evaporation under shed	Loss per day	Loss per day	Loss per day	Loss per day	Loss per day	Average loss per day	Loss in tons per acre
1	1.9″	2.83	2.5	9.5	9.0	6.25	9.5	6.0	8.1	17.70 tons
2	"	2.83	2.9	5.5	7.0	4.75	6.5	5.0	5.8	12.70 "
3	"	2.83	1.8	3.0	5.0	4.5	6.0	4.0	4.5	9.8 "
4	"	2.83	1.4	4.0	4.0	3.25	5.0	2.0	3.7	8.1 "
5	2.0″	3.14	1.0	4.5	3.0	4.25	4.0	2.0	3.6	7.1 "
6	2.0″	3.14	2.5	8.5	7.0	3.5	6.0	3.0	5.8	11.4 "
7	1.9″	2.83	2.2	16.0	17.0	10.75	17.5	15.0	15.3	33.4 "
8	1.9″	2.83	2.3	14.5	16.0	9.25	17.5	13.0	14.1	30.7 "

Table 2.—Showing average loss of water by evaporation per day

Evaporimeter No.	1	2	3	4	5	6	7	8
Average loss per day in gms.	8.1	5.8	4.5	3.7	3.6	5.8	15.3	14.1

Table 3.—Showing tons of water conserved by mulching

Evaporimeter No.	2	3	4	5
Tons of water conserved by mulching	5.0 tons.	7.9	9.6	10.6

The difference between the weight of water after adding water and the weight before adding the water is the actual loss of water by evaporation from soil surface. The evaporation is expressed in terms of gms. of water.

Conclusion and discussion :—

1. It is very clear from the experiment conducted that mulching reduces the loss by evaporation to an appreciable extent.

2. It is observed that saw dust mulch is more effective for evaporational losses than the soil mulch :—

The reasons are as follows:—(A) Capillary movement of water does not take place through the saw dust (B) It is a non-conductor of heat.

3. From the results it is evident that the deeper mulch is more effective than shallower mulch. Also deeper soil mulch appears more effective than deeper saw dust mulch when compared to the shallower mulches of the soil.

4. In all types of soils under study the amount of water lost by evaporation decreases as the water table recedes below the evaporating surface. It can be said therefore that ground water table does affect the rate of evaporation. In evaporimeter No. 6 the ground water table is 30″ below the surface whereas in the evaporimeter No. 1, it is 15″ below the surface. It is noted that the rate of evaporation in No. 6 is considerably lower than in No. 1. It is therefore inferred that deeper the ground water lesser is the rate of evaporation. Decrease in the evaporation in No. 6 is due to slower movement of capillary water, as the rate of capillary movement decreases as higher heights are attained.

5. The rate of evaporation is also dependent upon the texture of the soil, coarser the texture greater is the rate of evaporation. In sandy and silty loam the rate of movement of capillary water is very rapid. This accounts for the greater rate of evaporation in silt (No. 7) and Bardi (No. 8) than in clayey loam.

Practical importance.—The above conclusions clearly indicate the importance of mulching. The crop occupies the soil for about 6 months after rainy season. Naturally it requires water which should be conserved. A layer of loose dry soil is therefore an excellent preventive of evaporation of moisture from soils and may be regarded as the natural and most available means to be used by farmers both for prevention of evaporation and to moderate the access of excessive heat and dryness to the active roots. Of all the methods of moisture conservation the use of mulches has been found most satisfactory. The consideration of mulches is therefore one of the most important phases in the study of moisture control. By conservation of moisture more water remains in soil for the solution of essential elements and bacterial activity is encouraged, As a general rule more soluble plant food is likely to be found under a mulched soil, other conditions being equal, than under a soil not so treated.

Artificial mulches like that of saw dust can only be given in the case of intensive cultivation and specially for potted plants and fruit trees. Their use in the fields will mean a sort of obstruction for interculture and other operations.

MECHANIZATION OF INDIAN IMPLEMENTS WITH SPECIAL REFERENCE TO SEED-DRILL AND HOE*

By D. N. Kherdekar, (IV Year)

1. **Introductory.**—The present is a machine age. The progressive world has very widely used machinery in the agricultural sphere and has converted agriculture into a business. Agriculture should be, in fact, a business first and an art afterwards. If India is to thrive it must improve its agriculture, which is its real backbone, on business lines, which is only possible by introduction of machinery. Machinery gives maximum output with minimum cost which is the essence of business.

2. The problem of introducing machinery may seem very attractive but there are inherent difficulties in the way of the material realization of the problem with regard to the special conditions which exist in India. The first is the proverbial *conservatism* and an antipathy for machines existing in the farmers. This is no simple a psychological problem. The second is the *poverty.* The agriculturists are small proprietors and can hardly avail themselves of the machines which are really meant for large estates. Unless, therefore, there is either a consolidation or a scheme of co-operation amongst the plot-holders, machinery will neither be economical nor attractive. Thirdly, the machines require *technical skill* which is a matter of training and cost. The Indian farmer thinks that he is a born farmer and needs no training. Fourthly, the *capital* required for

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* A part of his Thesis for the B. Sc. (Agr.), Examination 1943. Work done under the kind guidance of E. A. H. Churchill, Esq., B.Sc., I.A.S., Principal, College of Agriculture, Nagpur.

purchasing the machines is not available. These are real difficulties and are probably unsurmountable.

3. The problem can never, however, be solved if the idea is only to introduce foreign machinery in Indian agriculture which must be left out of consideration as unsuited to Indian mind and soil. Instead of introduicng ready-made machinery, an attempt should be made to mechanize the Indian implements themselves which is the real solution of the problem. The mechanical principles may be thoroughly availed of and the implements which are now in vogue may be mechanized without loss of their nativity. They will then be at once effective and welcome to the rustics. With this basic idea the writer proceeded to mechanize the hoe and the seeddrill. An attempt is here made to outline the investigations and the results of mechanizing these implements.

4. The basic principles adopted in the investigation may be summarized as follows. These are ten basic principles which require no elucidation as they have been universally adopted by research scholars who try to effect improvements in Indian Agriculture. They are (1) Cheapness of the improvement (2) Certainty of the benefits obtained from it (3) Simplicity of the mechanisms (4) Availability of the spare parts (5) Ease at repairs (6) Use of *bullock-power alone* (7) Lightness of the implements (8) Close study of local conditions (9) Investigator's readiness to give ocular demonstration and proof (10) His unselfish motive at the introduction of the improvements.

5. **The scope of the subject.**—The implements generally in vogue in India are *four*:—(1) *Nagar* (2) *Bakhar* (3) *Doura* (4) *Tiphan.* The Nagar or plough has been studied by able persons and various new models are now available. The *Bakhar* being very simple did not attract the writer's attention. The third and the fourth of the above implements, however, have received special scrutiny and study in detail and the writer has been able to present as a result of his original research the "*New Intercultural Hoe*" which is a labour-saving device and the "*Improved seed-drill*" which is an attempt at mechanization of the crude Indian seed-drill (Sarta) so as to regulate spacing and to avoid loss of crop.

"The New Hoe".—Let us now proceed to the study of the first of the above two implements viz. the "*New Hoe.*"

The investigation on the implement was actuated by two main objects:—

(1) Saving of labour both of man and bullocks.

(2) Attainment of at least the same grade of work as that of the local '*doura.*'

The investigation was first directed to the study of the existing labour saving devices. A multiple doura called 'KOLAPA' is used in Marahatta countries (Poona) which is a combination of two or three douras attached to one log of wood, having a beam and a handle. This doura is a crude labour saving *device.* Though it can be used with the greatest advantage when crops are short, it cannot be used when crops grow high and get stiff due to wood formation in stems. Use of any such doura in later season breaks and damages the crops.

Another disadvantage is that, if the sown lines are not straight and either converge or diverge, the plants in such irregular lines are totally cut off.

A labour saving *practice* (or a device) is found in the Northern parts of C. P. and in the Madras Presidency in which three or even more (4, 5 and 6 in Madras) douras are at a time attached to a single yoke instead of to two. In Madras it is called '*Dhantalu.*' In this practice only bullock power is saved but not the man power.

The new implement must eradicate these defects. It must suit all crops whether young or full grown, it must be adjustable to irregular lines sown and at the same time it must save both bullock and man power.

Before stating the steps which have preceded this final construction, the writer succinctly presents the mechanism and working of the implement as follows:—

I. **Construction.**—The implement is made up of five main parts:—

(i) *The 'Y' shaped beam:*—(See figure '1' parts marked as Nos. 9 & 10).

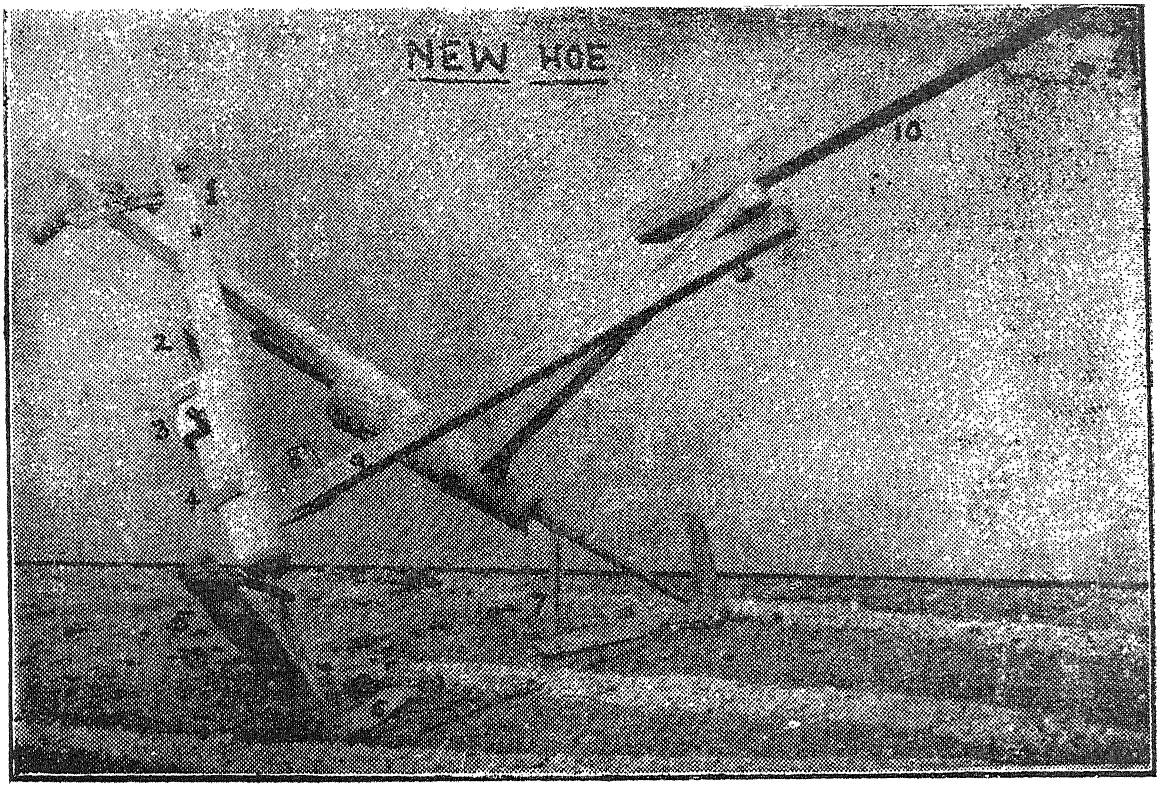
(ii) *The 'X' shaped body:*—(The same figure, part marked as No. 4).

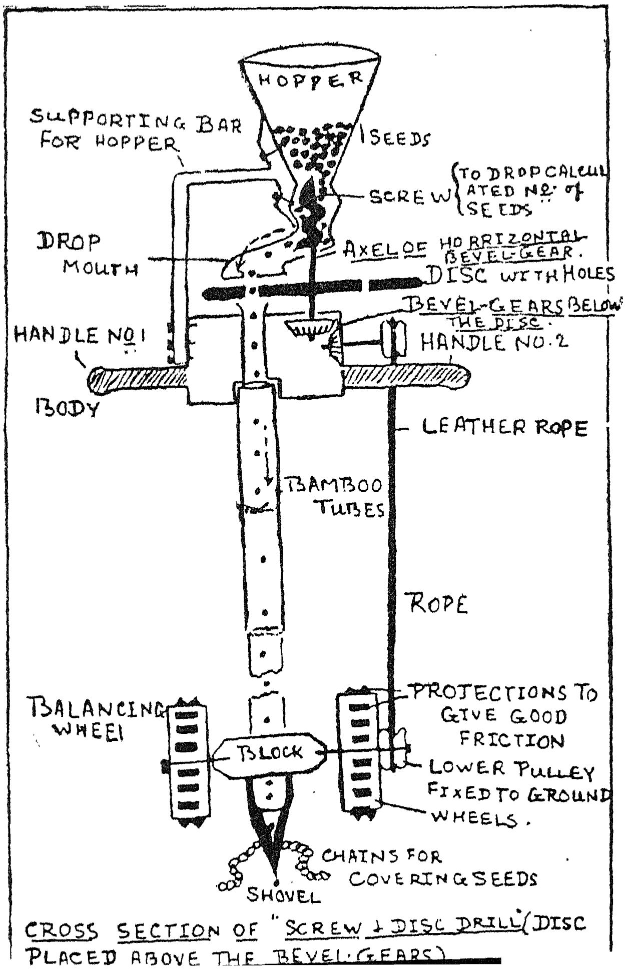
(iii) *The compound blade:*—It is composed of many parts (a) *Blade proper* (Nos. 5 and 6) consisting of blades of 12″ and 6″, (b) *Turner bend* (No. 2) facilitates giving semi-circular motion to the blade. (c) *Support* (No. 7). The blade is given penetrating angle and surface angle so as to effect proper pulverizing action and smooth working.

(iv) *The lock arrangement* (No. 3) helps to hold a particular blade in its proper position after the change has been made say from 12″ blade to 6″ blade. The lock has three notches one on each side and other in the middle. In these notches fixes the *key.*

(v) *The crescent and fly nut:*—If it is desired to key the two arms of X shaped body, this mechanism may be used.

II. **Working.**—Let us now see how it works and how it eradicates the above mentioned defects:—




HOPPER
SEEDS
SUPPORTING BAR FOR HOPPER
SCREW (TO DROP CALCULATED NO. OF SEEDS)
DROP MOUTH
AXEL OF HORRIZONTAL BEVEL-GEAR.
DISC WITH HOLES
BEVEL-GEARS BELOW THE DISC.
HANDLE NO.1
HANDLE NO.2
BODY
LEATHER ROPE
BAMBOO TUBES
ROPE
BALANCING WHEEL
PROTECTIONS TO GIVE GOOD FRICTION
BLOCK
LOWER PULLEY FIXED TO GROUND WHEELS.
CHAINS FOR COVERING SEEDS
SHOVEL

CROSS SECTION OF "SCREW & DISC DRILL" (DISC PLACED ABOVE THE BEVEL-GEARS)

(1) The height of the X shaped body used is 2′ to 2½′ and may be considered to be a reasonable maximum height to which crops are generally intercultured. Plants, therefore, remain safe underneath it and triumphantly hold up their heads as if no danger has passed over them. Thus the bending or breaking up of plants is avoided.

(2) The construction of the blade and the lock arrangement will very clearly demonstrate how the length of the blade can be changed as desired. What the labourer who works the implement has to do is, to give the blade a semi-circular motion as soon as he sees any irregularity in the sown lines. It has been observed in many cases that the lines sown are not straight (i.e. sometimes they converge or diverge). In such cases, the use of 12″ blade will not be convenient because it will cut the plants in the irregular lines. Hence the necessity of changing the length of blade from 12″ to 6″ so as to suit the altered spacing between the rows, and thus avoiding the loss of plants (See figure 1 where a 12″ blade has been replaced by a 6″ blade, the change being effected by a mere semi-circular motion of the 'Turner Bend' (No. 2 in Fig. 1) If further change in the length of the blade is desired, bring the *key* in the middle *notch* of the *lock*. By doing so we shall get a tyne-like blade which will work in a space of about 2″-3″. This has another advantage i. e. the implement can then be used for all the major crops which have different spacings. Cotton has 15″ to 18″ spacing in which case the implement can be used with both the 12″ blades adjusted. The same will be the case in case of Juar. In case of ground-nut the spacing is 12″ where 6″ blades can be used with advantage. Various combinations can also be used whenever desired. Thus we see that it can be used in cotton, juar, ground-nut and garden crops with advantage.

(3) The adjustment is so very simple that it can be effected by a quick and easy motion. The labourer can do this change in the length of blade without even stopping the implement. While working in the field a pair of such implements will be attached to a single long yoke as usual and worked with a pair of bullocks and two men, one for each implement. Thus four interspaces will be cultivated instead of two with the same amount of labour as is used in *Deshi Douras*, helping us to save half the bullock as well as man power. Thus the implement satisfies our needs.

III. **Origin of the idea and its development.**—This implement which was finally devised has gone through various stages and has an interesting history. The speciality of this implement, according to this writer is, in the blades which are made adjustable for various spacing.

The writer tried various experiments, which did not yield the desired effect and so they had to be discarded. It would be quite unnecessary here to mention those various experiments.

The idea of the compound blade was suggested by the tiny arrow-shaped '*Indian House-hold Churn*' or '*Ravi*'. Further experiments developed the idea and a card-board model was prepared which partially demonstrated the principle. The conviction could only arise on preparing a full-fledged wooden model and working it on the fields. A series of wooden models were prepared in the Handicraft School, Nagpur; each time the defects were removed and advice of experts was taken and lastly, the model here adopted was fixed upon.

IV. **The Estimation of 'Price' and 'Draft'.**—As observed in the opening paragraph the writer has taken care to see that whatever device he was using in the construction of his implement, it does not go beyond a certain cost price. The implement here presented has cost him Rs. 19 though he had to waste more in experimenting. The implement was prepared out of iron and wood. The price of iron was specially high due to the War, being three to four times the normal price. The writer believes that the implement will not cost more than Rs. 10/- in normal times which is within the paying capacity of every farmer. This price fairly compares with the total price of the implements which the farmer has to keep viz. Doura, Dundia and Duri (sold at an average price of Rs. 3½ per pair. The farmer has to keep a pair of each thereby costing him Rs. 10½ for the three pairs.) All the work of these three different implements can best be done by this *New-Hoe* as would be apparent from the adjustable blade which can be used for all crops (such as 12″ blade for cotton and Juar and 6″ blade for ground-nut etc.) having different spacing, which would otherwise have required different implements as stated above.

The method of working the implement and of yoking it is exactly the same as that of the ordinary *doura*. A pair of such 'Hoes' will be yoked to a long log of wood and will be worked by a pair of bullocks. The doubt, as is sometimes put forth, that the pull required is more and that it will be difficult to work a pair of such Hoes by a pair of bullocks, can be proved to be baseless by the following practical observations:—

1. In some parts of the Central Provinces and Madras Presidency 3 to 6 hoes are yoked to and worked by one and the same pair of bullocks.
2. A pair of bullocks works a *Bakhar* of 24″ blade, about 3″ deep causing 72 cub. inches of soil to be pulverized at a particular spot. In case of this 'New Hoe' *four* blades of 12″ length work, say to the depth of 1½″

of the soil crust. It means that in this case also 72 cu. inches of soil will be worked and if a pair of bullocks can do this work with a bakhar it can certainly do the same with this hoe.

3. Moreover, soil at the time of interculture is not as hard as at the time of summer Bakharing. At least Berar bullocks should not find it difficult to pull two such '*Hoes*' at a time.

V. **Inferences drawn from the results of the experiments done.**—Here we shall discuss some of the important inferences drawn from the results of the practical work done with this "New Hoe" and the defects which were noted during its work in the field. This '*New-Hoe*' was tried successfully by the writer on his fields at Basim and he had sufficient opportunity to observe its working. The experiments done on the Basim fields has produced the following results:—

1. The hoe produces good mulch and gives full work of a country *doura* and thus satisfies one test.

2. The height of the implement while working appears to be sufficient to keep the normally grown crops safe underneath it.

3. One man can work this hoe, thereby saving man-power. So also with bullocks. The bullocks need little guiding except at turnings.

4. The damage done to crops due to irregular lines, is saved by the compound blade and the rotating arrangement. The driver needs, however, a little training with which he will be able to adjust the blade according to space between the row without even stopping it and without any loss of time.

Besides the advantages the 'new hoe' claims to have a simple mechanism which can be manufactured and repaired by village carpenters and blacksmiths. It is a cheap labour-saving device.

VI. **Defects.**—The writer, however, is not blind to the defects which he has marked in the working and which he hopes to try to remove in future. The hoe, here presented has, it must be frankly admitted, the following important drawbacks:—

1. Much difficulty was experienced in obtaining proper balance. This may partly be due to the abnormally hard soil of 1941-42 due to the scarcity of rainfall, especially in Berar. Still it appears to be a defect which must be removed and which he hopes to remove after the "*Dynamometer*" becomes available to him in Nagpur.

2. Another defect was found to be in the 'key' which proved to be weak. The hoe needs a very strong key.

3. The iron bars (here used) of about half an inch diameter have a tendency to bend. Either stronger bars may be used or they may be

replaced by wooden bars to get rid of the defect. Besides, this would be a saving in cost. If iron bars have to be used they must not be less than ¾″ in diameter.

The hoe requires sufficient testing which might further suggest improvements. The hoe here presented is not the last word or a perfect machine (which can be introduced as such to farmers) but it is only an attempt which is believed should lead to the final implement that would give immense relief to agriculturists.

The new seed drill.—Let us now turn our attention to the investigation carried out in case of *seed-drill.* Though it is said that the Indian seed-drill is the most efficient of the implements (John Augustus Voelcker) yet it is found to be defective in material respects. It does not sow at regular distance in rows. This regularity in the distance between plant to plant in rows mainly depends upon the skill of the sower. But sowing skill is given to very few and generally on occount of lack of training the crops are seen in 'bunches' at some places and at others very sparse. This formation of gaps and bunching necessarily results in partial loss of crop.

This loss may fairly be calculated at 10% though the experts lean on calculating the same even up to 20 to 25%. Even taking the 10% loss to be the average, 7% is entirely due to inefficient sowing, the rest may be attributed to bad germinating capacity of the seeds, climate and such other causes.

This loss though seems insignificant appears very much magnified in the light of the "Grow more food" campaign, and has really given the writer the impetus to devise something, which would avoid the loss from bad sowing. The improvement having been directed to avoid the loss on account of the unskilled labour, it was thought that sowing should only be a mechanical process which the seed-drill must make up for the unskilled labour. Foreign mechanisms were studied but were found to be too complicated and very expensive. Many of the parts in those mechanisms were superfluous which could be easily eliminated in case of Indian seed-drill. Besides cheapness was the paramount consideration. For these reasons, the simple and handy 'Sarta' was taken up as the '*basis*' of improvement to be done.

I. **Construction.**—(See Figures 2 and 3)

Main parts of Improved Seed-drill are :—

(a) *Bowl* (See part marked as 1 in Fig. 2) (b) *Disc* (No. 2) (c) *A Handle* (No. 3) (d) *Top Pulley* (No. 4) transmits motion to the bevel gears and thereby to the disc which has a calculated number of holes from which the seed drops. (e) *Block* to hold the bevel gears and other parts. (No. 5)

(f) *Bamboo-tube* (No. 6) (g) *Rope-Belt* connecting the bottom and top pulleys (No. 7) (h) *Bottom Pulley* (No. 8) (i) *Ground wheel* to which bottom pulley is fixed (No. 9). This wheel transmits the motion. (j) *Bottom Block* carrying the two wheels and the tube (No. 10) (k) *Balancing Wheel* to take over the weight of the implement (No. 11).

Almost the same mechanism with few changes was done to the *Chada* of a '*Tiphan*' and that of a '*Nari-Plough*'.

II. **Working.**—The whole mechanism is attached to argada or *Bakhar* by means of a rope as in the case of ordinary *sarta.* ' The labourer holds the 'peg' or the 'handle' by his left hand and drops seed into the bowl by his right. Seed is carried by him in a gunny bag.

III. **Principle of Its Working.**—When the ground wheels are moved the pulleys transfer this motion to the bevel gears which in turn give horizontal rotating motion to the distributing disc. The disc has a calculated number of holes. The neck of the bowl just touches the disc leaving it free to rotate. When a particular hole on the disc coincides with the hole of the bowl the seed drops into the bamboo-tube which is then conveyed to the soil.

How the seed drops at regular intervals.—The power which rotates the 'disc' on which is dependent the dropping of seed, is obtained from the ground-wheel, which in turn, gets its motion from the bullocks. So, even if the bullocks walk fast, the ground wheel will also move fast and so will the transmission of this power to the disc by the pulleys and bevel-gears. Exactly the same but in reverse manner, will be the case if bullocks walk slow. The sowing will also be slow. Thus we find that the variation in the speed of the bullock or inefficiency of the labour will not in any way affect regular sowing. Thus the seed drops at regular intervals.

2. The interval will depend upon the principles of applied Mechanics. To determine the interval, the diameters of the ground wheel, pulleys, number of teeth on the bevel gears and the diameter of the disc will have to be taken into consideration. This being the first attempt, it was all roughly calculated to have the diameters of ground wheels to be 8″, of the pulleys to be 4″ and of the disc to be 6″. The seed drops at 2′ interval if such a disc has got one hole, at 1′ interval with two holes and at 8″ interval with three holes and so on. Further experiments will have, however, to be done by correctly calculating these dimensions.

III. **Origin of Idea and How it took the Concrete Form.**—However interesting the steps which led to the final implement may be to the author, they may not interest the reader and so the author would not dilate much on the same.

War-time especially gave him the immense trouble to find the bevel-gears, which the writer proposed to use. Chancely in the summer vacation at home, he came across an 'ice-cream pot' and an idea struck in his mind to use the bevel-gears of this ice-cream pot which he has actually used with advantage.

For the transmission of the power from the ground-wheel to the pulley '*Eccentric rod*' was tried but it failed because of insufficient *momentum.* The use of a bicycle pre-wheel and a chain was out of consideration due to high price. The problem of transmit'ing power to the disc worried the writer a good deal. The use of a rope instead of a chain was consoling. A 'notched' pulley was then prepared and a rope put on it so as to act as a belt and to give a positive drive.

IV. **Practical Demonstration given on Nagpur Experimental Farm** — This mechanism was worked and some of the defects found were removed.

Experiments were until further made on a piece of land which the Principal was kind enough to earmark for the demonstration. *Four* plots of soil were sown, *two* by Juar and two by ground-nut. Area of each plot was 1/40th of an acre. Close to these plots were other fields of the farm in which maize and ground-nut were sown with ordinary '*Sarta*'. So it was possible to compare the efficiency of sowing by this new seed-drill with that of the ordinary sarta by '*Ocular proof*'.

V. **Results of the Experiments.**—The sowing was done by attaching this 'Mechanism' to 'Argada'. Soil was moist. Doubt was expressed by many of the labourers on the farm as to the working of these ground wheels in the wet soil which was found on that day. The writer also thought the same way. But 'practical' experience showed quite the otherwise. The ground wheels worked well even though the soil stuck up to them.

The growth of crop was under close observation from time to time. It was found that plants grew at 'fairly' regular intervals. There was very little of 'gaping and bunching' when compared to the side fields.

VI. **Defects and Suggestions for their Removal.**—1. The interval between the plants could not be achieved with mathematical accuracy and it left a difference of one or two inches this way or that. There was no bunching or gaping except at places where the disc got jammed.

2. This jamming is not due to the wetness of the soil. Major obstruction was found to be done when broken seeds got in between the revolving disc and the bowl. This has to be guarded in future experiments.

3. The ground wheel works well even though the soil is wet. The rope pulley and the rope-belt efficiently transmit the power, without much slipping. Use of leather rope may be found to be of greater advantage.

4. Another significant defect was noticed, in that the end of the tube did not penetrate into the soil which resulted in irregular lines. But this defect is removable by using. '*shovel*' or a '*Coultor*'.

5. In the implement suggested, regularity in *feeding the bowl*, depends very much on the labourer. The idea is to make this feeding *automatic.* The automatic arrangement for regular 'feeding' will leave both the hands of a labourer free to hold and ply the implement, which would add to the balancing and guiding of the implement.

With this object in view two mechanisms were found out, one of which is illustrated in Fig. No. 3. The principle adopted is to make use of the *uselessly* rotating axles of the "Bevel-gears" while working the implement. There are two bevel-gears and so two such axles that could be made use of. Fig. No. 3 shows how to make use of the axle of horizontal bevelgear. The ground wheels and the top block or body do not alter but only a 'hopper' is attached over the bowl. A 'screw' like arrangement as shown in the figure No. 3 is attached to the axle of horizontal bevel-gear. This 'screw' works into the hopper. Evidently the 'screw' will get its motion from the bevel-gear. As the screw rotates a number of seeds from the hopper will be automatically fed to the disc. The black dots representing grains in the figure show this clearly. It is a matter of practical experiments to design and construct such a screw so as to get the desired number of seeds dropped. The same principle may be applied in the case of horizontal axle. The writer has some more designs to be worked into the implements here presented. But they have not the advantage of being tested. They, therefore, rest in theory merely and may aptly be termed as theoretical designs.

There are some devices concerning the above mentioned seed drill which entirely eliminate the use of bevel-gears. On the very same principle of the seed-drill a sort of *Dibbler* may be constructed by which the operation of dibbling the seeds will be easy and economic.

Mechanization of Indian Implements can be done by two ways, either as an original research or by merely taking and using up the already invented devices and adopting them to Indian conditions. If it is possible to do it by the latter way, it should be done and should not be discarded only because it is foreign, borrowed and not original. Whether original or not, we have to adopt such devices for the betterment of our agriculture.

With this aim in view, a *Labour-saving Hoe* can be designed on the lines of 'Foreign' "Single Bar Hoe with inverted shares" (Walker Co., Ltd.) with a few alterations that will suit our Indian conditions. Likewise a *New* Seed-drill can be devised on the principles of '*Walker Cup-Feed-Drill*' eliminating the superfluous mechanisms which are unnecessary under Indian conditions.

It will be worth trying to test the practical utility of the above mechanisms by experiments in the workshops as well as on the fields.

Conclusion.—The implements here suggested are not the last word on the subject. So far we have discussed only the outlines of the improvements done by *mechanization* of Indian implements. Real aid to farmers can be rendered with a yet deeper study. Mechanization of Indian Implements is well worth all the energy and brain we can put into it. It has been rightly remarked by Sir Alfred Chatterton, "If the people of India are to achieve any marked degree of success in the future, they must cease to neglect the mechanical engineering and must realise that in its application to agriculture lies a field open to immediate exploitation".

The idea of trying foreign machines and implements must be entirely left out of consideration. The improvement of implements must come 'from within and not from without' i. e. by the application of western mechanical science to native ways and requirements. This should be our watchword.

What is required at present is a steady work on the principles of mechanization and improvements from time to time in accordance with the dictates of fuller experience. The rule to be remembered is to satisfy cultivators' needs and not something which we imagine 'they ought to need.' The work is yet in its infancy and difficulties in the way of rapid progress are great. The task is not easy to achieve. There is no short-cut. Final success can only be gained by constant sincere work and practical experiments. Agriculture being the back-bone of India's prosperity all work done in the field of agriculture will be counted as an act of highest patriotism. With the mechanization let us hope India to be 'A garden ringing with cheerful and contented life, with smiling fields and food in plenty'.

College and Hostel Notes

After the spell of arid summer, the College opened on the 15th June 1942. The rush for admission to the College was very great. Our Hostel Warden S. K. Misra, Esq. M. Sc. (Agr.) gave the opening address to the new entrants, emphasising the necessity of practising the habits of punctuality and hard work.

It gives us great pleasure to congratulate the following of our friends for having attained a well deserved success in the University Examinations.

Mr. J. N. Hota, 1st Division in the B. Sc. (Agr.) Examination and the award of Sir Arthur Blennerhassett Memorial Medal and Chakradeo Memorial Medal.

Mr. A. C. Jain, 1st Division in the Intermediate Examination in Science (Agriculture) and the award of Sir Arthur Blennerhassett Memorial Medal.

Messrs B. B. Mishro and S. R. Chopde for having stood in the 1st Division in the B. Sc. (Agr.) Examination and Messrs M. N. Paithankar, K. G. Nema, A. L. Agarwal, J. R. Kakade, R. R. Rawat and G. N. Raut for having stood in 1st Division in the Intermediate Examination in Science (Agriculture.)

A notable change in the College Staff has taken place. V. G. Vaidya, Esq., B. Ag., Ph. D. has been appointed as Deputy Director of Agriculture, Eastern Circle and S. K. Mishra, Esq. Lecturer, has succeeded him. We take this opportunity to offer our felicitations to these officers. Both of them are distinguished past-students of our College.

The election to the various offices, in the various activities of the College was contested with great zeal. These College activities really afford a good opportunity to the students in training themselves for the good habits of selflessness, preseverence and industriousness. It is considered therefore, by every one who is elected to the office, that it is his responsibility to justify his election in the best manner possible. The following is the result of this year's elections.

General Secretary	... Mr. K. K. Yerawar III Year
General Secretary (for sports)	... Mr. R. N. Khandelwal III Year
Foot-ball Captain	... Mr. B. P. Misra, III year.
Hockey Captain	... Mr. G. D. Siriah, II year.
Volley-ball Secretary	... Mr. S. N. Khutate, IV year.
Tennis Secretary	... Mr. P. N. Bhargava, II year.
Secretary for Debating Society	... Mr. R. C. Jain, IV year.
Joint Secretary	... Mr. R. M. Rahangdale, III year.

NOMINATIONS

Mr. A. C. Jain, III year, Librarian, Hostel Library.

Mr. G. P. Misra, III year and Mr. P. S. Malviya, II year, respectively as the Secretary and Joint Secretary for the Association of Quiet Hour.

We congratulate all the above students and hope that they will show to us by their work that they have been rightly chosen for performing the duties entrusted to them.

This year 62 students were admitted to the 1st year. A large number of the applications had to meet with disappointment as they could not be taken in, due to lack of sufficient equipment in the College for a large number.

The Foot-ball and Hockey teams played with great zeal, but they could not succeed in annexing any of the trophies in the University tournaments. Only one tennis court is running this year owing to the high cost of balls.

The College Debating Society had made a good start this year, with the opening Debate under the Presidentship of our Principal Mr. E. A. H. Churchill. The resolution under discussion was, "At present India needs warriors rather than statesmen." After a short but excellent discussion, the resolution when put to vote was declared lost. We hope that more students will make use of such opportunities offered to them by the Society.

Two meetings of the Association of Quiet Hour were held. We were equally encouraged in this respect by the presence of our Hostel Wardens Messrs S. K. Misra and K. S. S. Iyer. We desire that the students should take greater interest in this activity.

We feel pleasure to congratulate our past students Mr. Ajit Singh, Mr. Bikram Singh Jogindra and Mr. Kumar Mohansingh for having obtained Emergency Commissions in the Army. We expect a grand success in their undertaking.

U. T. C.—Eleven new entrants to the College have joined the U. T. C. Lance Corporal G. N. Raut and Mr. G. R. Kokardekar who joined the Summer Senior Cadre course were placed in the first division. We congratulate Mr. G. N. Raut for his promotion as Corporal. One of our Staff members Mr. S. R. Pradhan joined the Officers Cadet Course at Mhow and obtained great success therein. This has brought an excellent chance to our U. T. C. Students for showing further progress by adding to their past glory and promotions too.

The Gymanasium and the Hostel reading room are well provided and are being fully utilised by the students. The studies are in full swing now.

We close this by thanking all the Office-bearers of the past year, for the great exertions that they incurred in performing their respective duties and the Principal and the members of the staff for their guidance from time to time, with a great zeal,

The Nagpur Agriculture College Magazine

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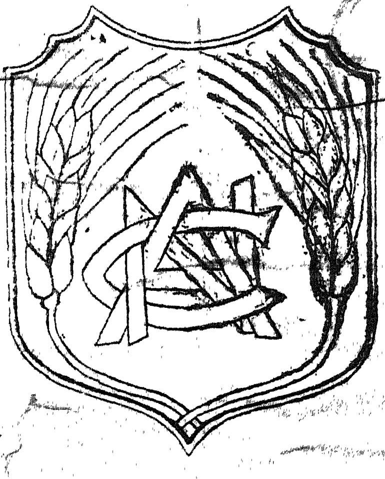

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The Nagpur Agriculture College Magazine

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Editorial

We offer our heartiest congratulations to Rao Bahadur D. V. Bal, M. Sc. (Agr.) (Hons.), A. I. C , F. C. S. (Lond.), Post Graduate, Pusa and Rothamsted (Eng.) on his being conferred the Ph. D. degree by the Nagpur University, at the last Convocation. He has the honour of being the first Scholar to attain the highest degree in Agriculture at this University. As a leading agricultural chemist he is already well-known. The conferment of the degree is hailed as a fitting recognition of his valuable researches.

* * * *

A CLEARING-HOUSE OF INFORMATION ON AGRICULTURAL ECONOMICS

The Indian Society of Agricultural Economics which was started in 1940 has extended its activity to a very useful purpose of collecting and marshalling all the available information on rural economics and conducting further surveys. The present sources of information consist of official reports and investigations carried out by Universities or bodies such as the Punjab Board of Economic Enquiry, the Bombay School of Economics and Sociology, etc. Many of the Provinces and States in India have yet little exact information collected on many rural problems. Such information when available is likely to be of great value in having a better understanding of such problems and will also be useful to the State and the Legislature in formulating a policy of development. The recent investigations carried out by the Marketing Adviser to the Government of India have brought to light many difficulties encountered by the cultivators and the losses they have been suffering owing to the lack of orderly marketing. Investigations of such a nature are likely to be of considerable benefit in tackling rural problems. The efforts of the Society deserve popular support.

Original Articles

THE JUARS OF THE CENTRAL PROVINCES AND BERAR

By S. C. Roy, L. Ag.

(*Offg. Economic Botanist for Cotton, C. P.*)

Andropogon sorghum, Brot. var vulgare, Sorghum vulgare, Pers, or juar as it is locally called, is the largest form of millet and consists of a very large group of plants, supposed to have been originally derived from the wild species of Andropogon halepensis. Its original home is often contended to have been Africa but there is considerable evidence to show that it was also known in India for a very long time and probably has an independent Asiatic origin as well. It is cultivated practically all over India, chiefly for its grain as a cereal food, which forms one of the staple food of a large section of the population in the Central Provinces and Berar, particularly in the districts of Nagpur, Wardha, Nimar and practically the whole of Berar. Nearly 4,104,967 acres are under this crop in these Provinces, out of which Berar alone grows about 3,583,393 acres. Being a crop catering both for man and beast, its importance in Indian agriculture is very high indeed, juar practically ranking only second to cotton in these Provinces.

As a rule, however, juar is not grown on the same land by itself, year after year. It is either grown as a rotation crop for cotton or sown as a mixed crop along with cotton or tur or both, the idea being, as said before, to supply the needs of both the farmer and his cattle.

The grain of juar is considered to be an important article of food for human consumption in these parts. In Berar it has practically replaced wheat in bread making and being cheaper, is universally used by the rich and the poor alike. It is too costly to be fed to cattle and, unless eaten by weevils or spoiled by rain, it is never so used. The fodder of juar, however, is very valuable as cattle food and is considered to be highly nutritious.

There are generally two crops of juar grown in these Provinces. The kharif and the rabi. The former of course is by far the biggest and the more important crop and is grown in practically all the districts of the Central Provinces and Berar, occupying an area of 3,254,941 acres, while the latter is more restricted and occupies only 850,026 acres.

Juar, as mentioned before, forms the chief rotation crop for cotton. It has been an age old practice. It is generally sown about the middle of July, and when grown for grain purposes is harvested about the beginning of December. For purposes of fodder, however it is sown considerably earlier, practically about the same time as cotton or immediately after cotton, when it is sown very thick. In earlier days or for the matter of that, even now too, cultivators are in the habit of growing juar along with tur or arhar, as a mixed crop, in many districts of C. P. and Berar. This is regarded by them to be a very useful combination, as, in some respects it undoubtedly is, and the acreage of such a mixed cropping in C. P., is sometimes as high as 897,221.

There are over 64 different varieties of juars found to be grown in these Provinces, differing from one another in the character of their grain and glume, habit of growth, earliness or lateness, etc. The following are some of the more important ones from amongst these:—

1. **Kharif juar.**—(a) Grain juar.

1.	Saoner	... Late
2.	Lamkansi	... Medium
3.	Amneri	... Medium
4.	Dhamna	... Late
5.	Detha	... Medium
6.	Nilwa	... Late
7.	Agia Kondal	... Medium
8.	Bedra	... Medium

(b) Fodder juar.

1.	Argar	... Early
2.	Fallar	... Early
3.	Langoor	... Early
4.	Jhalarian	... Early
5.	Pawan wandi	... Medium
6.	Kalabondi	... Early

(c) Grain and fodder combined.

1.	Ramkel	... Early
2.	Dhamna	... Late
3.	Satpani	... Late
4.	Alaspuri	... Medium
5.	Kansi Wani	... Medium
6.	Howri	... Medium

2. **Rabi juar.**—Ringni and Shallu are the two juars most commonly grown in this season.

With regard to fodder varieties, however, experience in Agricultural Department has shown that many of the grain juars, when sown very thickly, yield sufficiently thin stalks of fodder which are quite useful to the cattle for feeding purposes. Hence no special varieties are used for the purpose except those of the grain type which have been found to be heavy yielders, both in grain and fodder. These are known as dual purpose juars and are generally preferred to others when required for fodder purposes. Ramkel, for instance, has been found to be one of the best dual purpose juars and is always grown in these parts for fodder purposes, as, being a heavy yielder, it gives a full supply of grain, besides yielding a sufficient quantity of fodder.

Juars have been the subject of experiments by the Agricultural Department for many years but any really serious attempt at the improvement of the crop was only made somewhere about 1908 when a Botanist was appointed in the Province. In 1915 Dr. Graham published the results of his investigations in the Memoirs of the Department of Agriculture (Vol. VIII, No. 4) under the title "Pollination and cross fertilization in the juar plant" which included some genetical work regarding the inheritance of characters such as colour of the grain, length of the glumes, compactness of the head, etc. Subsequently however, this work had to be discontinued and only problems of economic character and of agricultural importance, directly useful to the cultivators were undertaken. Since then, research work on juar in these Provinces has been mainly directed towards its economic aspects only viz. the question of increased yields, its suitability as a rotation crop, its money return per acre, its value as a fodder crop, etc. As a result of this, a number of improved strains have been obtained by selection, giving considerably higher yield than the local juars. Experiments are also being conducted to find out the best form of manuring for juar, the best combination of crops to be grown in rotation to make it economically profitable for all the crops. As it is uneconomical or unprofitable to manure juar directly, the only way to do so is to apply the manure to cotton grown in rotation and note the residual effects of the manure next year on juar. A number of such experiments are being conducted by the Department on the Government Farm at Akola, the results of which are extremely interesting.

The yield of juar in these Provinces varies considerably according to the locality or soil on which it is grown. In Nagpur district, a yield of 600—700 lbs. will be considered to be fairly good, while in Berar an average crop will easily yield about 800 lbs. of grain. The average yield of juar in these provinces, recognised as the standard outturn by the Government is 656 lbs. Anything above that is reckoned to be a good yield for the crop. Besides the production of the grain, the fodder value of the crop to the cultivator is immense. A good variety sometimes yields about 8,000 to 10,000 lbs. of karbi in addition to the grain.

The results of yield trials conducted on the Akola Farm from time to time (Series C) are given below :—

Yield of Grain in lbs.

Name of juar	1933-34	1934-35	1935-36	1936-37	1937-38	Average of 5 years
Saoner	1856	1456	1116	1352	1288	1414
Ramkel	1804	1676	992	1380	1188	1408
E. B. 1	1916	1528	1080	1496	1196	1443
Dhamna	1820	1540	1180	1250	1268	1412
No. 123 A.	1852	1436	1264	Average of 3 years		1517
Lamkansi	1616	1512	1068	Average of 3 years		1399

In addition to these, a number of other strains 121 A, E. B. 3, No. 33, No. 92 etc., have also been isolated which appear to be highly promising and are still under trial. Nearly 22,235 lbs. of seed of these improved strains were distributed to the cultivators in 1940-41 from the Akola Farm.

The following table shows the average outturn of karbi per acre obtained from the different varieties of juars on the Akola Farm:—

		Average yield of karbi.
1.	Saoner	8285 lbs.
2.	Ramkel	7325 „
3.	Dhamna	8804 „
4.	Lamkansi	74_7 „
5.	No. 123 A.	8841 „
6.	E. B. 1	8992 „

This outturn of karbi, however, was obtained from juar grown for grain purposes. In cases where juar is grown particularly for fodder purposes, it is sown very thick and the outturn of karbi thus obtained varies from 15,000 to 20,000 lbs. per acre.

Summing up the above, the present position of juars in these Provinces may be said to be as follows:—

(1) The area grown under the crop in C. P. and Berar is 4,104,957 acres i. e. very nearly 1/6 of the total area of juars in India. The vastness of the area under it and the importance of the crop to the province certainly deserve greater attention than is paid to it at present.

(2) Though broadly speaking, a considerable amount of work has already been done by the Department towards the improvement of the crop in increasing its yield, etc., more systematic efforts should be made for conducting the research in greater details regarding the various economic aspects of the crop.

(3) The high yielding foreign varieties imported from the States and tried at Nagpur were found to be exceedingly early. Hybridization of these with some of the local ones is likely to yield useful results and is pregnant with immense possibilities.

(4) The grain of juar being the staple food of a very large section of the population of C. P. and Berar deserves more attention than what the Department is able to give to it at present. Here, as in other crops, the quality of the grain plays an important part, if not a very important one, in determining the total value of the crop.

(5) The genetical aspect of the crop has hardly been worked at except what little was done between 1915—1921. It is therefore of considerable importance that this should receive further attention and work on the genetics of the crop with special reference to the agricultural characters be restarted, to be further investigated and worked at.

TABLE 1

Summary showing average value, cost of production, gross profit per acre for complete cycle or cycles of rotations for all kinds of crops grown in the rotation experiments Series "A" of the Government Experimental Farm, Akola, calculated for a period of 8 years.

S. No.	Rotation	Avergae value per acre			Average cost of production per acre			Average gross profit per acre		
		Rs.	As.	Ps.	Rs.	As.	Ps.	Rs	As.	Ps
1.	Cotton groundnut alternately ..	107	1	0	53	3	0	53	14	0
2.	Cotton, juar then groundnut ...	128	6	0	45	4	0	83	2	0*
3.	Cotton, cotton, juar then groundnut ...	107	1	0	44	13	0	62	4	0
4.	Cotton, cotton then juar ...	73	8	0	40	4	0	33	4	0
5.	Cotton juar alternately ...	95	11	0	37	13	0	57	14	0
6.	Cotton after cotton ...	38	0	0	36	1	0	1	15	0
7.	Cotton, cotton then groundnut ...	94	13	0	48	5	0	46	8	0

* The above experiment clearly shows that a three course rotation of cotton, juar and groundnut is the best.

(Continued from the last issue)

SCOPE FOR THE EXTENSION OF THE CULTIVATION OF POTATOES IN THE CENTRAL PROVINCES AND BERAR

By A. B. S. Verma, B. Ag.,
(Lecturer, College of Agriculture, Nagpur)

3. **The problem of seed.**—The potato is propagated by means of its underground stems which get swollen with starch and are known as tubers. The real seed produced by fruits are used only by scientists in hybridization and evolution of new varieties. For cultivators the tubers are the seed for raising this crop. The potato seed is thus the bulkiest of all other seeds of cultivated crops. It is a seed of a very perishable nature under adverse conditions of transport and climate. It is, therefore, the costliest of all seeds.

(a) **The cost of seed.**—The cost of the seed at the distributing centres like Patna and Nainital may be as much as Rs. 2/11/- to Rs. 3/14/- per maund. But when it arrives in this Province it costs something like Rs. 8/- to Rs. 10/- per maund under ordinary conditions. But if the arrival of the wagons carrying the seed is at an unfavourable weather conditions like rainy weather, the seed cannot be planted soon; it starts rotting. If the weather does not improve soon the seed rots within ten to fifteen days in the godown of the dealers. In order to cover this risk of loss, the dealers always double the price and sell it at Rs. 12/- to Rs. 15/- per maund. Thus the seed for an acre in this Province would cost as much as Rs. 132/- to Rs. 165/- taking the seed rate as 11 maunds. Even when the arrival of the seed is not accompanied by any bad weather, the seed sells at Rs. 10/- per maund which means Rs. 110/- for an acre. Any idea of expansion of this crop in this Province presumes an investment of Rs. 110/- per acre at planting only, which, only a few cultivators are able to undertake without financial aid from any other source.

To this investment on seed, the cultivator must have a good financial stability to add Rs. 100/- as the cost of raising the crop. This leads to the examination of the amount of returns which may attract him to undertake this venture. A normal crop of potatoes yielding 110 maunds will fetch Rs. 220/- per acre, the selling price at harvest being Rs. 2/- per maund. The margin of profit will thus be depressed with every increase in the cost. The price of potatoes at harvest has no prospect of improvement in normal times, but there are several factors which always tend to raise the cost of seed at the planting time. The cost of seed is thus a very potent factor operating against the expansion of potatoes in this Province, unless special measures are taken to supply cheap seeds to the cultivators.

(b) **The seed required per acre.**—The quantity of seed required per acre will depend upon the size of the tubers and the spacing given to the crop in the field. The most economical size is between 1 oz to ½ oz in weight and 1″ to 1½″ in diameter. It has been reported that smaller tubers give higher yields than the larger ones. In Bihar and the United Provinces, tubers below 1″ in diameter are very popular. If the tubers are between

½″ to ¾″ in diameter the seed required for an acre may be 4 to 8 maunds. Seeds of 1″ diameter may be required to an extent of 12 to 14 maunds per acre. If the tubers are very small the seed rate may be as low as 2 maunds. The small sized tubers are popular, not only for their higher yield but also for their lower cost even if their selling rate may be as high as that of big tubers. When big tubers are available they are cut into sets and then planted. But the risk of their rotting being great, the cultivators prefer to plant whole tubers of smaller size. When planted at a distance of 24″ from row to row and 18″ from plant to plant, the number of tubers required per acre is 14,520, which will weigh 11 maunds if each tuber is one ounce in weight. The actual seed rate will vary from place to place.

(c) **The requirement of seed for this Province.**—The annual requirement of seed for this Province is estimated to be 37,000 maunds of tubers. Only (3,700 mds). 10% of this requirement is met by the produce of the growers themselves, especially in the Jubbulpore District. The rest of the quantity is imported from Patna, Farrukhabad, Nainital, Simla, Poona and Bombay. If the area under this crop were to be expanded, say, by 10%, the import of seed would increase by 10%.

(d) **The production of seed in this Province.**—The potato seed can be grown in this province in the same way as it is done in Bihar or the U. P. It has to be noted however that the seed deteriorates after two years of growing at the same place. It needs, therefore, a change every alternate year. As potato imported from Simla or Nainital is grown and acclimatised in Bihar before being exported to other Provinces, so also in the Central Provinces the potato can be grown in the first season in the cooler districts of Chhindwara, Saugor and Jubbulpore and then it can be fit for distribution as acclimatised seed to the other parts of the Province in the following season. This step would be governed by the factors affecting storage of seed, which is discussed in the following paragraphs. The best plan for a cultivator would be to put down 25% of the area of potato on his farm under imported seed and the remaining 75% under home grown seed. The former will provide sufficient tubers for his own requirement in the next season and there will be some to spare for the market. This way the possibility of diminishing returns operating as a result of continual use of home grown seed may be permanently put off. The financial and transport difficulties associated with the imported seeds would be considerably eased. At present only about 1,700 maunds (5%) of tubers are retained for seed purposes out of the total production of 325,000 maunds.

(e) **Varieties of seed.**—There are a number of varieties of potatoes classified according to their morphological characteristics. But the cultivators and consumers group them into a few big familiar classes only.

The varieties in demand in this Province are those which exhibit the following characteristics :—(i) Adaptability to the climatic conditions,

(ii) Resistance to diseases, (iii) Keeping quality, (iv) Consumer's fancies for medium sized tubers, round in shape, without deep eyes, the skin peeling off easily on cooking.

In this respect the Patna Red or Darjeeling Red is popular on account of its short growing period and high yielding capacity. It covers an area of about 30% in the plateau districts of Chhindwara and Betul. The Nainital or Simla Nainital is another variety of medium sized round white tubers which is very popular in the northern part of the Province occupying about 40% of the area under potatoes. The Italian White Round variety has been found suitable for growing during the rainy season on the hills where it covers an area of about 24%. The Farukhabadi and Darjeeling White are popular for their medium sized tubers, freedom from disease and high yielding capacities with outstanding keeping qualities, in the northern districts of this Province. It, however, is found in only 5% of the area under potatoes in this province. Other *desi* varieties are also grown in about one per cent of the total area.

For light sandy soils the Patna Red is very suitable. On hilly and loamy soils the Nainital and Farukhabadi may be grown. On red soils on hill sides, the Italian White Round has been grown successfully. In the other parts of the Province where the winter season ends by the middle of February the Early Patna Red variety will be the most suitable.

(f) **The storage of seed.**—The problem of storage of potato seed is of great importance and is continually engaging the attention of the research workers. The objects in storage have been to keep the seed under low temperature, good humidity and aeration to prevent rotting and decay caused by various bacteria. The storage investigations were done in three ways :—

(i) The seed potato is stored in suitable rooms protected from the hot winds of April and May and saturated atmosphere of July to August. This is done by keeping the tubers spread up in sand or ashes on specially constructed wooden or bamboo platforms. The loss of tubers has amounted to about 29.5 percent as found at Chhindwara. Most of the cultivators follow this method as this is the cheapest, though not a very efficient method of storage, the cost coming to about 6 to 7 pies per maund per month.

(ii) The second method is to store tubers under ground in trenches or pits. This involves the selection of a high lying site, construction of a shade or cover and filling of the tubers as recommended by the department. The tubers have to be removed before the rains set in and have to be kept in rooms as before during the monsoons. The loss of tubers is reduced to about 15.1% but the cost of storage increases to an anna per maund per month. The small cultivators would not take the trouble of storing in this way, rather they prefer to purchase the seed from outside.

(iii) The third is the most recent method of storage in cold rooms, where the loss of tubers is from 5 to 6% only. But this is not within the means of cultivators. It is for the business concerns to erect cold storage rooms in potato centres and store the seed of the cultivators as is done in other Provinces, where they charge from As. -/4/- to -/13/- per maund per month. This method has been found successful at Meerut, Sialkot, Patna, Jummu and Karachi. There are possibilities of establishing such cold storage rooms at Jubbulpore and Chhindwara.

Even if the cold storage facilities are not provided, the cultivators should try to store their own seed in spite of the high loss in storage, as this loss is great in other parts of India also, e. g. Bihar 57%, Bengal 20 to 64%, Poona 20 to 30%, the Punjab 12.5 to 30%. Even in the European countries the loss in storage in pits on farms amounts to 20 to 30%.

If the grower were to have his own seed even after incurring 50% loss of tubers he will not be a loser. If the selling price of potato is Rs. 2/- or less than Rs. 2/- per maund at harvest time, its cost will increase to Rs. 4/- per maund after deducting 50% loss. The cost of storage may range from a few annas to about Rs. 2/- per maund. The homegrown seed will thus cost him not more than Rs. 6/- per maund and will be available for planting at the most desirable time, while the seed imported from Bihar costs him at least Rs. 10/- per maund and is not always available at the time chosen by him for planting.

The homegrown seed has the disadvantage of deteriorating in quality and in productivity. The yield in Chhindwara and Jubbulpore Districts has been found to be less in productivity by about 20 to 25% when compared to that obtained from Patna or an imported seed. But this loss of 25% is made good by the premium got by bringing the produce early into the market in the months of October to December, when the tubers from the imported seed are still setting in the soil.

(g) **The import and transport of seed.**—About 90% of the seed required for this Province is imported from Patna, Farukhabad, Nainital, Simla, Poona and Bombay. The most common means of transport in this province is the railway. Motor buses and bullock carts are also used in transhipping small loads within the Province and into the interior of the country. A considerable quantity of tubers gets damaged in such transhipment on account of their packing in gunnies or baskets. The damaged tubers contract various diseases and become unfit for seed. The most important feature of the transport of such bulky seeds for longer distance is the doubling of the price from about Rs. 4/12/- per maund at source, to about Rs. 10/- to Rs. 12/- at Chhindwara. It is on this account that the potato seeds are not available to the cultivators in time. This is a significant factor coming in the way of expansion of this crop in any area.

4. **The problem of irrigation.**—The potato is a crop wholly raised under irrigation. It is a crop which does not grow well on over-saturated soils and would not form enough tubers if grown depending on the soil moisture exclusively, which is always sinking from day to day. In winter. The crop requires a saturation of about 30% to 35% in the first 12" layer

of the soil for a period of 3 to 4 months. If it gets desiccated beyond a certain limit (20%) the tubers do not develop properly and the crop suffers on this score.

(a) **The moisture contents of potatoes.**—The potato tubers contain about 78% to 80% of water at harvest. An average yield of 101 maunds of tubers means a harvest of 79 maunds or 3.75 tons of water only.

(b) **The water requirement of potatoes.**—According to Briggs and Shanz the potato requires, on an average, 1864±211 lbs. of water for every pound of tuber produced. While according to Singh it is 1573±65 lbs. per pound of tuber produced. According to the latter estimate 54.7 acre inches of water would be required for the crop. The total amount of water given by irrigation to an acre of potato crop is 35 acre inches. This is approximately 792 maunds of water for every maund of tuber harvested. Besides this a considerable amount of water requirement is met with from the reserve water in the soil received from rainfall.

(c) **The frequency of irrigation.**—The total amount of water needed by this crop has to be given to it over a period of 3 to 5 months at possibly equal intervals. The frequency of irrigation will vary according to the water holding capacity of the soil with reference to the rainfall and the climatic factors. On loamy soils or light soils in Chhindwara District, the crop is irrigated every 3rd or 4th day. In Jubbulpore, however, the crop is irrigated every 7th day on light soils and every 10th day on loamy or alluvial soils. Thus from 9 to 30 irrigations are needed to raise this crop on different soils.

(d) **The amount of water at each irrigation.**—The amount of water given at each irrigation varies according to the conditions which influence the frequency of irrigation. Sandy soils are given 1½ acre inches at each irrigation while loamy soils require 2 acre inches to maintain the desired condition of the soil. The area managed by wells and canals will thus depend on the frequency and the extent of water required by the crop.

(e) **Irrigation system in the province.**—There are 362 miles of main canals with 3019 miles of tributories irrigating 288,352 acres of land in C. P. But the irrigation canals and the tanks are classified as protective systems meant primarily for the rice crop of the Province. Other garden crops are given water only when there is no stress on water reservoirs. It is also not possible for the canals to supply water to small scattered areas of potatoes and as frequently as required by it.

The tanks.—There are private tanks in Chhattisgarh, Chanda, Jubbulpore and some other rice growing districts. These are primarily to supply water to the people, their cattle and the rice crop. The area under other irrigated crops commanded by these tanks is very meagre.

The wells.—The wells are the only source of water generally resorted to for irrigating potato crop in the province. The well water has been found to be very congenial to the growth of the potatoes and is always preferred by growers to the tank or canal water. The well water is warmer in winter and is thus more helpful for the development of tubers. But the area commanded by a well is very low depending upon its capacity, depth of water and the soil to be irrigated. A well 6′ in diameter, 25′ in depth with the water level at 15′ from the ground can ordinarily manage, with a moat, one acre of potato crop. This is a very serious limitation to any expansion of area of potatoes. Any well below 30′ in depth is uneconomical for irrigation by moat or rahat. The most common appliance for lifting water in potato gardens is the moat, probably because of its low cost (about Rs. 15/-) and negligible maintenance charges. The rahat is becoming popular with moneyed growers, who can invest more at the initial stages of the business. This may command nearly three times more area under the potato crop. The rahat proves to be an embarrassment if the subterranean spring of the well is weak and sufficient water is not delivered for its economic use.

Wherever the ground water is found at reasonable depths (15′ to 30′) the number of wells can be increased if the cultivators realise the importance of putting more areas under this crop. A kacha well (30′ x 7′) may cost only Rs. 100/- while a pucca well of the same size may require an additional amount of Rs. 250/- to 300/-. This cost may be considerably lowered if the cultivators were to utilize their idle months of summer to this task. But as will be seen later on, the net profit from an acre of potato crop will be about Rs. 130/- which by itself is an enough inducement to increase the number of wells for this crop.

5. **The problem of manure.**—Like many other profitable garden crops the requirement of manure and fertilizers is heavy for this crop also. A heavy dose of farm yard manure has been found very essential for raising this crop. In some other provinces, cattledung manure in a dose of 10 tons or 40 cartloads with other supplementary doses of lime phosphates and nitrates is found to be very effective. Phosphates hasten maturity and potash gives the potatoes resisting power against early blight.

In this Province the following manurial treatment has been found useful.

Farm yard manure	16,000 lbs.	or	Cattledung manure	17,920 lbs.
Niciphos II	220 „		Oil cakes	150 „
Sulphate of Potash	100 „		Ammonium sulphate	225 „
			Super-phosphate	216 „
			Potassium sulphate	205 „

In Assam, 300 maunds (10 tons) of farm yard manure per acre is found to be the most economical and productive dressing for this crop. Compost is found to be equally good.

Most of the fertilizers are not easily available in the villages and they are scarce during war time. But the cattledung is available in all villages and if proper care is taken considerable quantity of dung can be conserved for this purpose. The weeds and other shrubs growing on farm can be profitably prepared into compost for this purpose.

6. **The cost of cultivation.**—The cost of cultivation of a crop is a fundamental factor governing the expansion or contraction of its area. The cost of potato cultivation is fairly high and as such is beyond the comprehension of many of the cultivators who possess poor credits. Even some well to do cultivators would not be able to manage large areas under potatoes, if they are unaided by Credit Societies and Taccavi Loans. It would be a fatal mistake to consider the cost of cultivation alone without the profits accruing therefrom.

The cost of cultivation will depend upon the following factors.

The method of cultivation.—Potato grown alone would cost more than the potato grown with a catch-crop. Ordinarily the potato is grown on hills or plains without any rotation. The field, however, is heavily manured every year and is left fallow during the summer and rains. When the field is found giving diminishing returns, the crop is changed and crops like garlic, onions, brinjals etc. are grown in that area.

There is, however, a definite system of double cropping i. e. growing potatoes after chillies on the plateau districts of Chhindwara and Betul. The field is cropped with chillies between May to August and then with potatoes from November to February. The organic manure is applied to the chillies in April and the residual effect is utilised by the potato crop. This method has been very successful and is to be recommended on two scores. Besides the additional net income of Rs. 69/- per acre from chillies the danger from insect pests harbouring in the unrotten or partially rotten dung manures are completely removed. The white ants, cockchafer beetles, and snails are less operative, if at all, in a field manured this way.

A deep cultivation is the keynote for the successfuil raising of the potato crop. On alluvial soils, flat beds may be prepared but on all heavier types of soils, ridges and furrows 2′ wide are most suitable for this crop. When the planting is done immediately after the preparation of ridges and furrows or within 2 to 3 days of it, the germination of tubers is good. In freshly prepared ridges and furrows, the soil is mellow and the placing of tubers in the soil is done quickly without injuring their sprouts or skin.

The potatoes are planted as whole tubers during the early part of the winter i. e. in October and November in the north of the Province, while big tubers are cut in sets containing 2 to 3 eyes or buds on each and are planted in the latter part of the winter i. e. from December to January. The cut sets are treated with wood ash, slaked lime etc. before planting. But the whole tubers are safer to handle and quicker to germinate and are thus more dependable as seeds. The tubers should be planted at 2″ to 3″. deep in the soil as those exposed to light do not germinate satisfactorily.

Timely and judicious irrigation is very essential in keeping down the cost of cultivation. The first irrigation is given just after planting and the second should not be repeated till about 75% of the tubers have germinated. After germination, regular waterings may be done as discussed under the problem of irrigation. Special attention should be paid at the time of formation of tubers so that the soil may be uniformly moist. The period between the 5th and the 9th week of the crop is important when it should not be subjected to lack of water.

For raising seed; the potato is planted in loamy soil without heavy dose of manure and is lifted when the plants are completely dry. The tubers for seed should be exposed in shade for sometime before storing as this will harden their skin and lessen the quantity of moisture and earth sticking to them.

The cost of seed.—The potato seed is always costly and to reduce its cost small sized tubers between ¾ to 1 oz. in weight should be preferred, as small sized tubers are found economical to grow. The tubers imported in C. P. from Bihar and U. P. do not, of course, allow the advantage of selecting such tubers for seed.

The efficiency of labour and its cost.—The labour required for raising this crop is an important item of expenditure. A grower, working himself on his own field, puts in his best efforts and at the right time while a hired labourer works only for the love of his wages. A tactful supervision is always needed to get a good work from such labourers. It is always advisable to command the good will and sincerity of farm labour by occasionally giving them any surplus and culled produce, for instance, small sized potatoes got from the bottom of heaps. This will evince a great interest amongst them and will go a long way in maintaining their good will.

The efficiency of labour has been recognised to operate successfully in lowering the cost of production. The efficiency is attained by continual working in a particular direction of the work. It is, however, difficult to compare the efficiency of rice transplanters to that of cotton pickers. But for general work connected with the management of labour and raising of crop, it may be compared in the following way :—

The owner cultivator	100%	efficient	earning average daily wages	-/8/-
Male worker of cotton tract	80%	,,	,,	-/5/-
,, of wheat tract	70%	,,	,,	-/4/-
,, of Plateau dist.	66%	,,	,,	-/3/6/-
,, of Chhatisgarh	50%	,,	,,	-/3/-

This estimate has been made from observations with regard to ploughing and bakharing of land in the various tracts. The cost of raising potatoes will thus be effected by this factor in various tracts of the province.

The cost of manure.—Leaving aside the imported fertilizers which sell at prices depending upon extra-provincial factors, the cost of cattle dung manures is a considerable amount. Applying at the rate of 40 cart loads per acre, it will require an investment of Rs. 20/- in Chhatisgarh, Rs. 30/- in wheat tract, and Rs. 40/- in cotton districts.

7. **The problem of diseases and pests.**—The potato suffers from a number of diseases caused by fungi, bacteria, virus and insects, both in the storage condition and in the field. The damage done may be quite negligible in some cases, or it may be a complete loss of the crop. As most of the causative factors are ordinarily invisible to the naked eye, the cultivator is always too late to diagnose the malady and he has to suffer an inevitable loss. The following are some of the important diseases attacking this crop.

(1) The *early blight* is caused by fungus attacking the plants and tubers. The plants lose their leaves in severe attack. The tubers develop discoloured spots on the skin.

(2) *Bactrial soft rot* of tubers is caused by bad storage.

(3) *Black heart* is caused by inadequate ventilation in storage or field.

(4) *Ring Disease* or *Bactrial wilt* is a serious disease sometimes appearing suddenty when the plants wilt away with or without yellowing of the leaves. The tubers also start rotting. It spreads by contact in transit or storage.

(5) The *tuber rot* is caused by several species of *fusaria*. Its control is not very easy. Rotation of crops, selection of breeding of resistant varieties and avoiding the damage of tubers help to check the disease.

(6) *Fusarium wilt* is brought by an infected seed or infected soil. The plants wilt and die away quickly with yellowing, bronzing and crumpling of leaves.

(7) *Hollowheart* is caused by too rapid or an irregular rate of growth in wet seasons or in very fertile soils.

(8) *Black scurf* or *Rhizoctonia* manifests itself in the death of young sprouts and the appearance of clusters of sprouts with their tips killed resulting in the failure of germination. The plants get knotty and the tubers are formed in the axils of leaves.

(9) *Mild mosaic* is seen as mottling of the green leaves with slight crumpling. The yield is lowered considerably.

(10) *Rugose mosaic* is a very severe disease resulting in premature deaths of plants accompanied by mottling and crumpling. This spreads rapidly, helped by the aphids.

The grower however should not get discouraged by this big list of diseases. Scrupulous cleanliness in the selection of seed, sorting out the diseased tubers and plants in storage or in the field, rotation of crops, proper irrigation and manure with prompt application of fungicides like the Bordaux mixture are the keynotes in the control of these diseases. Ventilation of the crop in fields, of the tubers in storage or transit, avoiding of bruising, cutting or damag of tubers at harvesting, not allowing the potato haulms to rot as litter in the field are also essential to check contamination of healthy plants of tubers.

Termites and beetles also damage the crop in heavily manured fields. But the damage from these has not been very serious. The potato moth is a serious pest of the tubers in storage. Dry ash and sand are used to cover the tubers to prevent the moth from laying eggs on the stored tubers. The affected tubers must be sorted out and destroyed, regularly.

8. **Summary.**—The scope of expansion of potato crop in the province has been discussed. The climatic and soil factors are found to be favourable for this problem. There is a great demand for potatoes for table purposes. The culled or rejected potatoes may be diverted to the manufacture of industrial products. At present large quantities of potatoes are imported from other provinces. If suitable arrangements for the supply of cheap seeds and irrigation facilities are made, this crop can be grown in an increased area.

9. **Suggestions.**—1. The area of this crop may be expanded gradually from year to year on a ten year plan.

2. Selection of hardy, short duration varieties with lower water requirement may be done.

3. The existing irrigation facilities may be improved by encouraging the sinking of new wells in suitable areas.

4. Co-operative seed stores for potatoes may also be started. As individual cultivators cannot erect cold storage centres, Co-operative societies or business magnets may be invited to open cold storage centres as in Karachi and Bombay.

5. Universal containers for transport and storage may be evolved. The bags and baskets are not suitable for transport of seeds for long distances.

6. There is a need for subsidiary industries to develop for utilizing the rejected, culled, or partly decomposed tubers as in power spirit industry or starch and glucose industry. This is an essential factor on which the expansion of potato crop in any country is based.

7. Grading of potatoes may also be practised.

The cost of cultivation of potatoes per acre

Place ... Private farm, Chhindwara Labour rates Bullock pair -/6/- a day
Soil ... Sehra (sandy loam) Man -/3/- „
Source of water... Well—30′ deep ... Woman -/2/- „

	Items	*Labour required*			*Cost*		
		Bullock pair	Men	W.	Rs.	A.	P.
1.	Cost of 40 cartloads manure (10 tons) @ -/8/- each				20	0	0
2.	Carting „ in 1 day	3	3	3	2	1	0
3.	Hire charges for 3 carts @ -/2/- each				0	6	0
4.	Spreading and mixing manure by bakhar	1	1	...	0	9	0
5.	Uprooting and collecting chillies' stubbles	...	...	6	0	12	0
6.	Ploughing once in August, twice in Sept. with country plough 6″ to 8″ deep	3	3	...	1	11	0
7.	Two bakharings in Oct. @ 2 acres a day	1	1	...	0	9	0

	Items	*Labour required* Bullock pair	Men	W.	*Cost* Rs.	A.	P.
8.	Making ridges and furrows (with country plough) 18″ apart	1	1	...	0	9	0
9.	Dressing the ridges and making plots	...	12	...	2	4	0
10.	Cost of seed, 11 mds. @ Rs. 10/- per maund				110	0	0
11.	Sorting out diseased tubers	...	...	4	0	8	0
12.	Planting in the 4th week of Oct. 12″ apart, 1½″ deep		...	8	1	0	0
13.	Irrigation, just after planting (1½ acre inch, by moat of 30 gallons capacity working 8 hrs. a day @ 2½ days per acre	2½	5	...	1	14	0
14.	Second irrigation after 13 to 16 days (as above)	2½	5	...	1	14	0
15.	Nineteen more irrigations at 2 acres per day	38	38	...	21	6	0
16.	Two weedings by contract @ Re. 1/- per acre	...	...	...	2	0	0
17.	Earthing up after one month of planting (between weedings)	...	...	16	2	0	0
18.	Lifting @ -/2/- per bag of 2 mds. for 135 mds. (average)	...	...	62½	8	7	0
19.	Interest and depreciation on well, bullocks, implements, land revenue and kotwari cess.		...	...	19	1	0
20.	Interest on outlay of Rs. 200/- @ 6¼%	...	...	...	12	8	0
21.	Miscellaneous	...	...	...	0	9	0
				Total	210	0	0

Cost of producing chillies as a secondary crop

					Rs.	A.	P.
1.	Cost of seed, 2 seers dry chillies ...				1	0	0
2.	One cart manure for nursery ...				0	8	0
3.	Preparing nursery, 30′ x 10′ ...	0	1	0	0	3	0
4.	Irrigation of nursery once in four days for 1 month.	1	1	0	0	9	0
5.	Ploughing twice in April ...	2	2	0	1	2	0
6.	Bakharing once ...	½	½	0	0	4	6
7.	Ridging ...	1	1	0	0	9	0
8.	Dressing ridges and making plots ...	0	12	0	2	4	0
9.	First irrigation @ 3 days per acre ...	3	3	0	1	11	0
10.	Transplanting in the middle of May	0	0	6	0	12	0
11.	Uprooting seedlings for above ...	0	0	1	0	2	0
12.	Second irrigation on second day of planting ...	2	2	0	1	2	0
13.	Nine more irrigations till middle of June, every 3 days, doing ½ an acre per day ...	18	18	0	10	2	0
14.	Two weedings @ Re. 1 per acre ...				2	0	0
15.	Earthing up ...	0	0	16	2	0	0
16.	Picking fruits twice a week, in all 6 pickings of 10 mds. each, @ 8 female coolies per acre ...	0	0	48	6	0	0
17.	Share of land revenue and depreciation etc. ...				9	8	0
18.	Interest on outlay of Rs. 40/- @ 6¼% ...				2	8	0
19.	Miscellaneous ...				0	11	6
	Total cost for raising chillies ...				43	0	0
	Total cost for raising potatoes ...				210	0	0
	Total cost for raising chillies and potatoes ...				253	0	0

Income:	Sale proceeds from potatoes, (135 mds. or 45 *pallas*) at Rs. 8/- per *palla* on spot at Chhindwara ...	360	0	0
	Sale proceeds from 60 mds. green chillies at Re. 1/14/- per mad. at Chhindwara ...	112	8	0
	Total sale proceeds ..	472	8	0
	Deduct total cost of cultivation ...	253	0	0
	Net profit from an acre ...	219	8	0

APPENDIX 'A'

Meteorological records of some Potato Centres of India

Province:	Stations	Elevation in ft.	Mean temperature							Mean Humidity							Rainfall						
			Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
United Provinces	Meerut	737	83	76	65	58	57	62	73	68	56	54	62	63	57	50	4.0	0.5	.1	.3	1.0	.7	.7
	Agra	555	84	80	70	62	60	65	77	67	48	43	53	56	47	38	4.3	.4	...	.2	.5	.3	.2
	Allahabad	307	83	78	68	61	61	66	78	80	69	64	69	68	58	43	6.7	2.3	.2	.2	.8	.4	.4
	Benares	267	83	78	68	61	61	66	77	78	66	60	63	62	54	41	6.5	2.1	.1	.1	.7	.5	.4
	Lucknow	369	85	79	69	61	61	66	77	72	60	53	58	59	52	43	7.1	1.4	...	.5	.8	.3	.3
Bihar	Patna	183	84	80	70	62	61	66	78	80	70	61	65	67	58	46	7.9	2.9	.2	.2	.7	.5	.3
	Darbhanga	166	84	79	71	63	62	65	76	83	77	69	75	71	63	54	9.9	2.8	.1	.2	.4	.5	.3
	Gaya	375	84	80	72	64	64	69	81	78	65	55	57	54	45	37	7.0	2.5	.2	.2	.7	.5	.4
Central Provinces	Saugor	1769	77	75	69	64	63	67	78	78	55	42	45	46	39	32	7.3	1.3	.4	.7	.6	.5	.2
	Jubbulpore	1341	79	74	66	61	62	66	76	79	65	56	58	59	50	38	8.3	1.5	.3	.3	.6	.5	.5
	Seoni	2030	71	73	66	63	64	68	77	76	59	50	51	52	45	34	8.2	1.9	.4	.7	.7	.9	.5
	Raipur	960	80	77	70	66	67	71	80	79	67	59	56	54	49	40	7.7	2.2	.8	.3	.3	.3	.6
	Nagpur	1025	79	79	77	71	67	69	73	76	60	52	52	52	42	32	7.8	2.3	.4	.5	.6	.4	.6
	Akola	930	78	77	70	66	68	73	82	75	61	51	51	47	36	28	5.8	2.2	.4	.8	.5	.1	.4
Hill Stations			Jun.	Jly.	Aug.	Sep.	Oct.	Nov.	Dec.	Jun.	Jly.	Aug.	Sep.	Oct.	Nov.	Dec.	Jun.	Jly.	Aug.	Sep.	Oct	Nov.	Dec.
	Pachmarhi	3528	78	71	70	70	67	60	56	65	89	90	83	61	53	54	14	25	23	17	5	1	2
	Chikalda	3656	75	69	68	68	69	65	62	69	91	92	89	63	55	53	15	24	22	19	6	2	2
	Darjeeling	7421	59	54	48	43	40	39	47	92	92	94	94	87	79	81	28.4	28.5	28.5	16.9	7 5	.1	.5
	Ootcamand	7252	56	55	55	55	54	53	51	84	84	82	79	89	90	71	6	5.6	4.2	3.7	9.8	2.9	1.6

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VEGETABLE CUTIVATION IN THE CENTRAL PROVINCES AND BERAR

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CALENDAR OF OPERATIONS

The growing of vegetable is usually a very lucrative occupation for cultivators whose lands lie on the outskirts of large towns. It is also an interesting and at the same time a paying hobby for those who can maintain a small kitchen garden at the back of their houses or even in their yards. As such therefore it is essential that there should be a sort of gardening calendar which would tell persons interested in gardening particularly the layman, as to when and how and which of the vegetables are to be planted, what after-care would be necessary, and what means should be adopted to make it economically successful. Gardening calendars therefore are useful in suggesting things that may be done rather than things that must be done. Much depends on the ability of the cultivators to take advantage of climatic conditions as they occur, to sow and plant under the most favourable conditions available. It is not possible, however, to provide a perfect gardening calendar for the whole of the Central Provinces and Berar, as variations will occur according to the nature of the soil, climate and character of the season, e. g. the time of occurence of rainfall, its period of duration, the total amount of rain received etc. But it may be generally stated that the months of June and July, on the one hand, and October and November on the other, are the best planting seasons for kharif and rabi crops respectively. The scheme suggested in the following pages therefore, should only be taken as the basis on which to work and may be modified according to weather conditions and local circumstances prevailing in a particular locality. While describing the details of cultivation of the main crops, cultural operations suitable to their requirements have been recommended. These may be regarded only as suggestive, since local conditions as well as those of weather vary considerably from place to place and from year to year. The chief point to be borne in mind is that it is of utmost importance to have all operations pertaining to the cultivation of vegetables done at the proper time, and to do this, a considerable amount of planning is necessary in order to determine the particular crop that should be put in in each of the plots occupied at the moment by something else. The main idea is that the land must, at all times, be kept occupied by some crop or other, and recuperated, judiciously by heavy manuring, in order to bring in the maximum amount of profit to the owner, from the minimum area of land, which is technically known as "intensive farming." For this purpose, a sort of calendar of operations has been given below so as to indicate the type of crop that may be grown in a particular month and the type of operations necessary from time to time for its successful propagation. Details of these are given month by month.

JUNE

Arum and Ginger.—Soil suitable—Rich sandy loams, preferably a deep, well drained and open soil.

Manuring—Farm yard manure at the rate of 2½ ghamelas (weighing roughly 50 lbs.) for a plot of 100 sq. ft. is applied as a basal dressing and spread evenly before the land is ploughed. A mixture of 5 oz of Ammonium Sulphate, 8 oz of Superphosphate and 3 oz of Potassium Sulphate may be applied later, just before actually laying out the land for the crop. In the absence of fertilizers, however, the dose of farm yard manure may be increased to 4 ghamelas for every 100 sq. ft.

Cultivation.—The land should be ploughed deep by means of Turn Wrest plough or forked as soon as the last crop is taken off and bukhered, a number of times or pulverised to get a fine tilth up to a depth of 6″. When the land is thoroughly prepared, it should be laid out into long furrows 2′ apart, if the land is level, otherwise in short furrows also 2′ apart, if the land is sloping. In the latter case "kyaries" 12' x 10' with ridges and furrows may be laid out with a ridging plough or even by a country plough with a wooden plank fixed between the share and the beam or with phawras.

Planting.—As soon as the laying out of the beds is completed, well developed corms or rhizomes that have already started sprouting are selected for planting. This is done in equi distant little pits 9″ apart and 3″ deep, prepared on either side of the ridge, half way between the top of the ridge and the bottom of the furrow, in such a way that the sets alternate on either side of the ridge. The latter are pressed down into the pits, covered with soil and the whole surface smoothened out by hand. For planting an area of 100 sq. ft. about 2 to 2¼ lbs. of corms or rhizomes are required.

Turmeric.—This is grown on deep, loamy soils as well as on medium black soils which should be naturally well drained. The cultivation of the land and its preparatory tillage, manuring and laying out are identical with those already described for arum and ginger. In this case, however, a better method of lay out may be adopted with advantage viz—the broad ridge method, in which the land is laid out into ridges and furrows, the latter being 4' apart while the intervening space forms the flat ridge, 2½' in width. For purposes of planting, well developed, sprouted, disease-free sets are to be selected. Sprouting can be induced by heaping up the rhizomes in a dark and cool place. The heap is covered over with leaves which are plastered down with a pasty mixture of cowdung and earth. In about a month's time, the sets begin to sprout. After the rains have set in, these are planted in 2 rows on the bed 1' apart, the same distance being maintained between plant to plant. Each set is placed in a pit about 3″ deep and carefully covered up with soil. Roughly about 2½ to 3 lbs. of turmeric sets are required for planting a plot of 100 sq. ft.

Sweet potato.—Soil—It requires a well drained, lighter type of soil preferably a sandy loam.

Cultivation.—The land should be prepared as for arum and ginger and manured with 2½ ghamelas of farm yard manure along with 6 oz. of Ammonium Sulphate, 8 oz. of Superphosphate and 5 oz. of Potassium Sulphate for a plot of 100 sq. ft. If fertilizers are not available, the quantity of farm yard manure is increased to 3 ghamelas. The land should be laid out into ridges 2' apart, in case of loamy soils. For heavier soils, however, raised beds 2½' in width, separated by deep channels 18″ wide, will be more effective. On sandy soils, planting may be done in check beds.

Planting.—The crop is propagated vegetatively. "Cuttings" or "Slips" are made up from healthy vines, each slip having 4 to 6 nodes. While planting, the middle portion containing at least 2 nodes are buried in the soil, at a depth of 2″ or 3″, leaving the nodes at the two ends free, to be above the ground. For this purpose, apical and younger portions of healthy vines are finally selected. If planting is done on ridges, slips are planted on both sides of the ridge in such a way, however, that plants alternate on either side of the ridge at a distance of 2' from one another. On heavier soils where raised beds are made, sets are planted in two rows, one on each side of the bed at a distance of 6″ from the channel. Planting should be done alternately as in the case of ridges.

Gourds.—Ashy gourd (Bhura Kumda), Luffa (Ribbed and sponge gourd), Bitter gourd (Karela), Red gourd (Kaddu), Cucumber (Kakdi), Bottle gourd (Dudhi or Lowki), Snake gourd (Padwal or Chachinda), Squash or Vegetable marrow :—

For all these, the land should be prepared as for arum and ginger and manured with 2½ ghamelas of farm yard manure for a plot of 100 sq. ft. The land should be laid out in flat beds 12′ x 6′. Pits 1½′ x 1½′ x 1½′ are dug 4′ to 6′ apart. These are filled in with a mixture of farm yard maure and soil and kept ready for sowing. 8 seeds are planted in each pit and thinned out afterwards to four of the best plants.

Ladies' Finger and Roselle.—Seeds of these are sown in flat beds in lines 2′ apart and a distance of 3″ is maintained between seed to seed in the row to begin with. In case of Roselle these may be thinned out to 6″ between plant to plant, while for Bhindi the thinning may be further extended, keeping the plants a foot apart.

Beans.—Lima bean or Double or Butter bean, Broad bean (bakla sem), Asparagus bean (Barbati), Sword bean (Hara sem), Country bean, Velvet bean (Katch khurri), Four angled bean or Goa bean (Choudhri or charkoni sem), Cluster bean (Gavar phalli) :—

Soil.—Beans require a lighter type of soil that is not too rich. A black soil, light to medium in character, would suit very well.

The land is cultivated thoroughly and manured as for cucurbits. Seeds are dibbled at a distance of 12″ to 15″ and in rows about 4 feet apart. Sword bean, however, will do well in rows 5′ apart, the distance between the plants in row being 2'. The seed rate for Lima bean and Cluster bean is about 1/3 oz. for an area of 100 sq. ft. whereas the others require about 2/3 oz for the same area.

Chillies, Brinjals, Tomatoes and Gooseberries:—These should be sown in nursery beds at the end of May and transplanted at the end of this month.

The land however, should be prepared before hand, after being well cultivated and manured with 1½ ghamelas of farm yard manure along with 2 oz. of Ammonium Sulphate, 4 oz. Superphosphate and 6 oz. of Potassium Sulphate for an area of 100 sq. ft. If fertilizers are not available, the quantity of farm yard manure may be increased to 2½ ghamelas. The land is then laid out in ridges and furrows 2′ apart and 2 or 3 seedlings together, in case of chillies, and one only in cases of brinjal and tomato, should be planted at a distance of 18″ to 2' at the sides i. e. half way between the crest of the ridge and the bottom of the furrow. A cloudy day or an evening is always preferable for transplantation. If there is no rain, watering should be given immediately after planting is over. In order to maintain a continuity of supply for the market, fresh nurseries of these may be sown in this month, to raise seedlings which may be transplanted in the next month.

The nursery beds should be laid out on a high lying portion of the field in close proximity to the supply of water. Such portions, however, should be burnt down with grass or waste matter, in order to destroy the insects and other pests which usually infest the land. Beds, 6' x 3', raised 9″ to 12″ above the ground, should be prepared with the addition of farm yard manure at 3 ghamelas for an area of 100 sq. ft. The seeds should be sown either broadcast or in lines 4″ to 5″ apart and covered over with soil. It should be watered immediately with a watering can, which will have to be continued for a week, morning and evening after which flow-irrigation may resorted to in case no rain is received in the meantime. Shades should be provided to protect the seedling during the hottest part of the day and also during heavy showers. Seed rate for these should be as follows:—

Chillies 1/8th of a tola for a plot of 100 sq. ft. Brinjals and Tomatoes 1/14th tola for a plot of 100 sq. ft.

The beds should be kept free from weeds and stirred after each irrigation. In case of an insect attack, spraying with lead arsenate or hand picking may be resorted to.

Artichoke (Jerusalem):—This may be grown in almost any kind of soil. The land should be well cultivated and manured as in the case of arum. It is grown from tubers which are generally planted 15" to 18" apart, in rows which are at a distance of 2' from one another. The planting is usually done in the 3rd week of June.

JULY

Arum, Ginger, Turmeric, Lady's finger and Roselle.—The land may be weeded and kept clean and the soil stirred as frequently as the rains permit. In order to have a continuity of supply, regular sowings of ladies' finger at an interval of a fortnight may be done.

Sweet Potatoes.—Weeding is necessary in the early stages of growth, but once the plants become established the thick cover thus formed will prevent weeds growing to any appreciable extent. The trailing stems of the plants should be turned back on the ridges periodically to prevent adventitious rooting, as otherwise it will tend to decrease the size of the original tuberous roots.

Ashy gourd.—Luffa, Bitter g urd, Red gourd, Cucumber, Bottle gourd, Snake gourd, Squash and Beans :—

Weeding and stirring of the soil form the main items of work in this month, as being in the thick of the rainy season, no watering will probably be necessary. These being all climbers, machans 6' in height may be erected and the vines trained to climb over and spread on them. All gourds are liable to be attacked by red pumpkin beetles. These attack both the foliage and the flowers, and the best remedy is to pick them up in the morning and destroy. Spraying with lead arsenate may be tried. 2 or 3 oz. of lead arsenate to 4 gallons of water, to which ½ lb. of gur has been added will make a suitable mixture. Wood ash freely sprinkled over the plants, in the morning when the crop is wet with dew, is also considered to be a preventive measure. For purposes of a continuous supply, fresh sowings may be done in this month in the usual manner.

Chillies.—These having been transplanted in June will now require interculture operations for turning down weeds and stirring of the soil. This is best done by means of khurpi, particularly in smaller areas.

Brinjals, Tomatoes and Gooseberries.—The soil in between the plants should be kept free from weeds and stirred by working with a khurpi till the plants are earthed up. Top dressing at the rate of a tola of Sodium Nitrate or Ammonium Sulphate or a handful of oil cake may be applied to each plant in this month. Dead plants, if any, should be replaced. In case of tomatoes when the plants are still small, shoots coming out in the axil of the leaves may be removed and the plants tide loosely with plantain fibre to a stake, care being taken to allow the main shoot to continue its growth without hindrance. Topping is done when it reaches the top end of the stake which is about 3½ feet from the ground. If desired, however, 2 or 3 branches may be trained and retained while the others are cut off.

Cauliflower, such as Early Patna, Benares and Faizabad.—Nursery—Seedlings of these may be raised from acclimatised seeds in nursery seed beds as described in last month's note. When the plants are three weeks old, they are transplanted in a second nursery bed 3′ square and planted in rows 3″ apart and 2 inches between plant to plant. As the seedlings attain a height of about 6″, they are again transplanted finally to the field where the spacing between plant to plant is increased to about 15″, the rows being laid 2′ apart. During the intervening period of growth in the nurseries, care should be taken that the beds are free from weeds and caterpillars, and the soil stirred after each irrigation.

AUGUST

Arum, Ginger and Turmeric.—Weeding and stirring of the soil form the main items of operation for these crops in this month. A hand hoe or khurpi may be used for the purpose throughout the growing period. The earthing up of these should be taken up in order to cover the plants properly, as the tuberous stems are likely to be exposed on account of scouring through heavy rains.

Sweet Potato.—The vines should be continuously turned over from time to time to prevent the nodes from sending out roots into the ground that might develop into small tubers which are useless. Tubers should be allowed to form at the nodes that have been inserted into the soil while planting and should not be exposed, as they are liable to be attacked by beetles. Weeding should be continued, whenever necessary.

Ladies' Fingers.—These come to fruiting 7 weeks after sowing and the pods which are getting ready should be plucked and sent to the market. These should be removed while yet in the young and tender stage as otherwise they become too tough and stringy for table use. Some plants often turn yellow and wilted due to attack of insects. These should be pulled out and burnt. Timely weeding and stirring of the soil should be continued till the crop is finally removed.

Cucurbits and beans.—These being sown at the end of June will be about a month and a quarter old now and will require the usual care of timely weeding and stirring of the soil. The vines should be trained to climb up the machan so as to get fixed up properly. In case of an attack by red pumpkin beetle, the remedy described in last month's note should be promptly adopted.

Chillies, Brinjals, Roselle, Artichokes and Gooseberries.—Weeding and interculture operations may be continued as in other crops.

Tomatoes.—Pruning of side-shoots, as advised in last month's note should be continued. The first-formed ones are easily nipped off with the fingers, but, for the removal of the older ones a knife or pair of scissors should be used, as there is danger of disease developing through the cut. As the plants are about 2½ months old now, cluster of flowers may be seen on the stem opposite the axils of the leaves. When the fruits develop and grow bigger in size, the stem should be tied properly to the support, so that the weight of the fruits may not drag the stem down. As the tomato plant is very sensitive to excessive rain, it is essential to drain off the accumulated water as early as possible. It is advisable to apply at this time a top dressing of sodium nitrate at the rate of 4 oz. for a plot of 100 sq. ft., care being taken to mix it with four to five times its bulk of fine dry soil or sand, in order to ensure even distribution. Weeding and stirring of the soil should be regularly continued.

The later sown seeds of chillies, brinjals and tomatoes as described in June, will be ready for transplantation in the beginning of this month. The cultivation, manuring laying out and transplantation may be done exactly as was done for others.

Turnips.—The land should be well cultivated, and manured with 1½ ghamelas of farm yard manure and 9 oz of Superphosphate per acre. If Superphosphate is not available, the quantity of farm yard manure may be increased to 2½ ghamelas. The land may be laid out in ridges and furrows 1' to 1½' apart. Sowing is done either continuously in row, half way between the top of the ridge and bottom of the furrow or in small groups at a distance of 6″ to 8″ apart. When seedlings are well established, these should be thinned out and a distance of 9″ to 12″ is maintained between plant to plant.

Cauliflowers, Cabbages, Knolkohls, English Tomatoes, Brinjals, Lettuce and Onions:—

Seedlings of these should now be raised in the nursery beds for the cold weather crop, exactly in the same way as described above.

In case of onions 10 lbs. of seed are sufficient to sow 500 square feet of nursery beds, whereas for others, about 12 oz. of seed will be enough for about 250 square feet.

The following varieties of the undermentioned crops have been tried at Nagpur and found to be the best.

Cauliflowers.—Early varieties—Early Patna, Benares, Faizabad, Snow ball, Earfurt, Paris and the Early giant.

Late varieties—Magnum, Benum, Welchurn and large Aseatic.

Cabbages.—Conical, Early, York, Early Oxheart, Drum head, Early dwarf and John's day early.

Knol kohls.—Early green and Early purple.

English Tomatoes.—Oxheart, Mekado, Perfection, Excelsior and Cherry.

Brinjals.—Long purple, Round purple, and Muktkashi.

Lettuce.—Cabbage and Cos lettuce.

Onions.—Red and white.

SEPTEMBER

Gourds, Pumpkins, Ladies' Finger and Gawarfalli.—These will be in full swing now and the plucking of the fruits may be started and the produce sent to the market. In case of Snake-gourds when the fruits are 6" long, small stones may be tied to the ends of the fruits in order to prevent them from becoming knotty or twisted. The fruits of Pumpkins (Kumra) when fully ripe are gathered and unless sold immediately are hung up till required for use. White gourd is largely used for making a sort of sweet meat called Petha. In the case of squash Luffa Bitter-gourd, Bottle gourd etc., care must be taken to gather the fruits while still tender as they become hard and woody if left over for long. The squash is harvested by cutting the stem about an inch from the plant so as to leave very little of it that can be used as a handle and which if broken might leave a scar likely to start rotting. These should be handled with care if they are intended to be kept long. Cucumbers should be gathered when full grown, but while still green. These should not be allowed to become over ripe if required for pickles or table purposes, for, as soon as the seeds are matured the plant commences to dry off, while if the fruits are constantly gathered when green and not allowed to ripen, the plant will continue bearing fruits for a longer period. Weeding and mulching should be continued as usual.

Sweet-Potatoes, Goose-Berries and Artichoke.—The land may be weeded and kept clean and the soil stirred as frequently as the rains permit.

Arum, Ginger, Turmeric and Beans.—These may now be irrigated if there is a break in the rains of more than 15 days duration. Weeding, stirring of the soil and earthing of plants should be continued from time to time after every heavy shower of rain. Top dressing of well powdered ground-nut cake or castor cake at the rate of 1 pound of the former and 2 pounds of latter for a plot of 100 square feet may be applied.

Tomatoes.—These should by now be getting ready for the 1st picking. It is more convenient to pick a tomato just as it starts colouring and ripen it indoors, than allowing it to ripen it on the plant itself. These should then be kept for ripening in a shady place away from the sun when they ripen quickly. Those fruits which come off easily should be picked off at once but if a pressure is required to be exerted, it is better to leave it alone till the next day. Picking should be done every 3rd or 4th day. The usual trouble with the crop is the mite, mosaic and the fruit rot. As there is no remedy for these, the only precaution that should be taken is to pick all the affected fruits and destroy them. Hand weeding and stirring of the soil should be continued whenever necessary.

Turnips and Roselle.—Weeding and stirring of the soil should be continued whenever necessary. Turnips will be getting ready for the market and may be gradually removed. In order to maintain a continuous supply, fresh sowings of turnips may be made in this month as well in the usual way.

French beans.—The land is thoroughly cultivated and manured as for other beans and laid out in ridges and furrows 1' apart. Seeds are sown on the sides of the ridges 6" to 9" apart and 2" deep. Irrigation may be given if there is no rain. 1¼ oz. of seed will be sufficient for a plot of 100 square feet. For purposes of continuous supply, fresh sowings at intervals of a fortnight may be continued up to the end of December.

Garlic.—The land should be well cultivated and manured with 1½ ghamelas of well rotten farm yard manure along with 8 oz. of Ammonium sulphate, 4 oz. of Superphosphate and 2 oz. of potassium sulphate for every 100 sq. ft. of land. If fertilizers are not available, the quantity of farm yard manure may be increased to 2 ghamelas. The land is laid out into beds 12' x 6' and irrigated. Cloves of garlic are then sown one at each place at a distance of 4" between plant to plant and in rows 9" apart. In a bed of 10' square about 1¾ pounds of dry cloves are required for sowing. This gives a seed rate of approximately 700 pounds per acre.

Beet, Radish, and Carrot.—The land should be well cultivated and manured as for turnips already described. It should be laid out into ridges and furrows 12" to 18" apart and irrigated. Seeds are sown only when the soil has dried a little. The sowings may be done either continuously in a row half way between the top and bottom of the ridge or in small groups 6" to 8" apart. The seedlings when well established may be thinned out keeping a distance of 9" to 12" in beets, 4" to 6" in radish and 4" between plant to plant in case of carrots.

As the carrot seed usually takes about 12 to 18 days to germinate it should be soaked in water for 24 hours one day previous to its sowing and mixed with 3 to 4 times its bulk of fine dry soil of sand in order to ensure even distribution. For a plot of 100 sq. ft. 1/5 oz. of seed will be sufficient for sowing.

Chillies and Brinjals.—These being about 2½ to 2 months old should be fruiting now. Pods should be picked up as they ripen and allowed to dry. If any unripe chillies happen to be collected they should be separated out, as unripe pods turn white in drying which spoils the appearance of the whole sample for the market. The pods after gathering should be spread out on a clean dry ground and left to dry for about a week or 10 days, when they are collected and stored. If necessary green pods may also be collected and sold as such. Weeding, and hoeing of the crop should be attended to. In case of brinjals the fruits should be removed before the seeds mature. These are picked off the plant with the stalk attached. The chillies are attacked by "Moorda or Churda" disease caused by mites, thrips or powdry mildew in this month. Spraying or dusting the plants either with lime sulphur or with finely ground sulphur has been found to be very effective.

Cauliflowers.—These are transplanted in this month, having been sown in nursery beds at the end of July.

Soil suitable.—Rich sandy loams, preferably deep, well drained and open soils.

Manuring.—Farm yard manure at the rate of 2½ ghamelas for a plot of 100 sq. feet. is applied as basal dressing and evenly spread before ploughing or forking, along with a mixture of 10 oz. Ammonium Sulphate and 6 oz. of super phosphate applied before actually laying out the land for the crop. In the absence of fertilizers, however, the dose of farm yard manure may be increased to 3 ghamelas for every 100 sq. ft.

Cultivation.—The land should be ploughed deep by means of a Turn Wrest Plough and bukhered a number of times or in the alternative forked properly to get a fine tilth up to a depth of 6″. When the land is thoroughly prepared, it should be levelled and then laid out in long furrows 2' apart if the land is level otherwise in short furrows also 2' apart, if the land is sloping. In the latter case 'kyariese' 12' x 10' with ridges and furrows may also be laid out with advantage after working up with a ridging plough or a country plough or even with a phawra worked by hand labour.

Nursery.—The nursery area should be irrigated about 8 to 10 hours before the seedlings are taken out for transplantation in order that the soil may become soft and loose and the seedlings removed without injury to the roots. The seedlings should be taken out with a khurpi and carried in a basket with wet soil sticking to the roots. Transplanting should be done in the afternoon, preferably in the evening, in order to avoid excessive loss of moisture through transpiration from the young plants.

Planting.—As soon as the laying out of the plots is complete, the area should be irrigated and the transplanting should be done in furrows. The best spacing required for cauliflower or cabbage plants is from 18″ to 20″ between plant to plant according to variety while for knolkohl it should be 9″. After the 1st irrigation, two more irrigations should be given at short intervals i. e. from 3 to 5 days so as to enable the seedlings to strike roots properly.

If the weather is hot, the seedlings should be protected from the sun by covering with a sort of hood made of leaves for a week or so or until they are well established in the soil. Casualties should be immediately replaced by fresh seedlings from the nursery, otherwise the field will not have a uniform stand.

Irrigation.—Immediately after transplantation, the watering is done more freqnently for some time mentioned above, but later on after every 10 to 12 days. About 9 to 10 irrigations are usually given.

After care.—The most important operation after the establishment of the seedlings consists in mulching for the preservation of moisture in the soil after each irrigation. The soil is stirred frequently and weeds eradicated. Earthing should be done when the plants have grown up sufficiently. The field should be inspected often for fungoid diseases, insect pests and parasites, and immediate steps should be taken to control them.

Spinach, Coriander, Methi, Chuka, Chakwat, Chandan batwa, Sapu and Choulai.—Cultivation and manuring operations are the same as for other garden crops. Beds 10' by 6' or 12' by 6' may be prepared according to convenience. Seeds should be broadcasted evenly and mixed with the soil, care being taken to give timely watering in the earliest stages.

Nursery.—The seedlings of cold weather crop such as Cabbages Cauliflowers, Knolkohl, Onions, Tomatoes and Brinjals etc. which have been sown in August in the nursery beds should be well looked after. Weeding, stirring of soil and irrigation should be continued. The seedlings of Cauliflowers and Cabages, however, should be transplanted in a 2nd nursery bed 3' square and planted in rows 3″ apart and 2″ between plant to plant. In case of an attack by caterpillers, the remedy described in the month of July should be promptly adopted.

OCTOBER

Cabbages, Cauliflowers, Knolkohls, & Lettuce.—These are all cold weather sowings and are transplanted in this month having been sown in nursery beds at the end of August. When the seedlings are ready, transplantation may be done in the same way as described in case of Cauliflowers in September, except that lettuce should be planted in flat beds at a distance of 9″ between plant to plant and row to row.

Potatoes.—These are sown about the middle of October. The preparatory tillage and the amount of manure given are much the same as described for onions. Ridges and furrows 2' apart are laid down with a ridging plough or phawras and cross furrows 10' apart are prepared with the same plough for water channels. "Kyaries" are then made by an ordinary spade for facility of watering. Potatoes are ready for planting when the eye buds are found to have sprouted into growth. Tubers of medium size about 2 oz. in weight are selected for sets but in cases of large ones they are cut into two pieces. 2 to 2½ lb. of potatoes furnish sets sufficient to plant an area of 100 sq. ft. Pits 3″ deep and 9″ apart are dug in the furrows. A set is planted in each pit and carefully covered; the beds being immediately watered.

Beet, Turnips, Carrots, Radish etc.—These having been grown directly in their own plots from seed in the month of September do not require to be transplanted now. Thinning is usually done in this month, the distance maintained being 9″ to 12″ for beet and turnip, 4″ to 6″ for radish and 4″ for carrot as described before. Timely irrigation, weeding and mulching should be attended to. For purposes of a continuous supply fresh sowings of seeds at regular intervals of a fortnight or so would be of considerable advantage.

Peas.—Cultivation is the same as for other garden crops. The land is laid out in ridges and furrows 2' apart and the seed is dibbled in the furrows about 2" apart in two separate rows along the base of the ridges. The 1st irrigation is given within a week of sowing and subsequent waterings may be given every 12th day. Mulching and weeding should be attended to, after each irrigation.

Arum, Ginger, Turmeric, Goose berry, Artichoke, Roselle, Sweet potato French beans; and Garlic.—Timely irrigation and mulching are the only important operations in this month for these crops and should continue as usual.

Onions.—These are usually sown directly on the land in this month, but if transplantation is desired the seeds should be sown in nurseries in August and the seedling transplanted in October. The cultivation and manuring are the same as in garlic, except that oil cakes at the rate of 10 oz. for a plot of 100 sq. ft., may be used if fertilizers are not available. These, however, should be applied to the land before laying out the plots. On lighter soils check beds 9' by 9' may be made, while on heavier soils, ridges and furrows 2' feet apart would be better. Seedlings are planted at the sides of the ridges 6" to 9" apart in two separate rows, care being taken to nip off the tops to reduce transpiration. The after care is exactly the same as in cauliflower.

Mint.—This may be grown in a small plot for use as a condiment or spice. It is propagated by runners. The leafy shoots are planted in well prepared beds, which are a foot apart while a distance of six inches is maintained between the plant in the row. The crop continues to supply green leaves throughout the year. It is watered weekly and must be kept free from weeds.

Gourds and Pumpkins.—In these, well grown fruits, while still tender, should be plucked, cleaned and sent to the market. Those, however, that have become already over grown and hard may be left over for seed purposes. While plucking, care should be taken to handle the fruits properly, as fruits bruised or otherwise injured decay more rapidly than uninjured ones. Timely weeding, watering and mulching should be attended to.

Tomatoes, Brinjals, and Chillies.—These being grown in hot weather in June will be in full swing now and picking of fruits should be continued from time to time. The usual precautions regarding the method of plucking tomatoes and ripening them indoors as suggested in last month's note. The brinjals should be plucked every four or five days. The chillies may be picked as they ripen and allowed to dry. Unripe chillies should be kept separate and sold green. Hand weeding, mulching and irrigation should be continued whenever necessary, care being taken not to give too frequent waterings during the period of fruit development particularly in the case of tomato crop. As the soil from the ridges frequently gets washed down during irrigation earthing up of the crop may be done whenever necessary.

For ensuring a regular supply, fresh plantings of these should be continued in this month also.

Spinach, Coriander, Methi, Chuka, Chakwat, Chandan-Batwa, Sapu, Choulai and Ghor.—These having been sown in the last month, now require the usual care of timely irrigation and weeding. For a continuous supply, sowing of seeds at regular intervals of a fortnight or so would be of considerable advantage.

NOVEMBER

Cauliflower, Cabbage, and Knolkohl.—These should be about 2 to 2½ months old and the plants owing to transplantation in the last month will have attained considerable growth and size. Great care must be exercised to prevent the breakage of roots while mulching. A soil mulch should always be maintained after each irrigation. This will check the growth of weeds and help to aerate the soil. A hand hoe or khurpi may be used for the purpose throughout the growing period of the crop. Plants should be examined from time to time for fungoid diseases, insects pests and parasites and immediate steps should be taken to control these, if any. For purposes of having a continuous supply, fresh sowing at intervals of a fortnight should be made. This however is not possible for Cabbage but may be practised for Knolkohls and to a certain extent, for Cauliflower.

French Beans.—These should be ready for picking now and the pods may be collected regularly for the market, as otherwise any delay in doing so even for a day, spoils the quality by making them too tough and fibrous and lowers their value. Picking, however, of pods which are too tender is also undesirable, as it tends to decrease the yield.

Onions.—These will now require regular hoeing at certain intervals, to keep down the weeds and to maintain the surface tilth, care being taken not to nick the stem of the young plants, as damaged plants do not bulb freely. Irrigation may be given whenever necessary.

Spinach, Coriander, Methi, Chakwat, Ghore, Chaulai, Chuka and Chandan-Batwa.—These having been sown in September should now be ready for the market and may be gradually removed. Those sown in October, however, will require the usual care of timely irrigation and weeding while for ensuring a regular supply, fresh sowings at definite intervals of about a fortnight should be continued. The beds that have been cleared of the crop may now be worked up with a fork and manured, in order to prepare them for the next crop.

Beet, Turnip, Carrot, Garlic, Chilly, Mint, Lettuce. Radish and Potato.—Timely irrigation, weeding and mulching should be attended to. Lettuce and Radish, however, will be ready for the market and may gradually be removed. Fresh crops of these may be obtained from time to time by timely planting at regular intervals in order to have a constant and regular supply. The earthing up of potatoes should be taken up in order to cover up the plants, as they are likely to be exposed on account of scouring through frequent irrigation.

Sweet Potatoes.—These should be getting ready for lifting, as the leaves will have turned completely yellow by now and dropped. The best time for harvesting is determined by lifting up a few roots and examining them. If these, when cut through, allow the sap to dry up quickly, forming a white crust they are mature. If, however, the sap continues to remain as such i. e. in a liquid form the indication is that crop should be kept on for some time longer. The roots should not be kept unlifted too long, as they become liable to attack from the sweet potato weevil. The harvesting is done by cutting the vines close to the ground and then digging up the ridges either by a pickaxe or a fork. The tuberous roots are then gathered cleaned and stored in a cool place until sent to the market. The land should be forked up immediately after the basal dressing of manure has been applied and prepared for next crop. 20 lbs. of sweet potatoes are generally obtained in a plot of 100 sq. ft.

Chillies.—These should be picked as they ripen and allowed to dry. Unripe chillies should be kept separate and sold green. Timely watering and weeding should be attended to. As soil from the ridge gets washed down during irrigation, earthing up of the crop may be done if necessary.

Tomatoes.—These will have finished by now and the remaining crop may be harvested and sent to the market. Empty beds should be dug up after the application of manure as usual. The produce per 100 sq. ft. usually amounts to 16 lbs.

Gourds and Pumpkins.—These will have finished their lives by now and the remaining fruits may be gathered and sent to the market. The empty beds may be worked up with a fork after farm yard manure has been spread over them and the beds made ready for the next crop.

Beans and Artichokes.—These being sown at the end of June will be about 4 months old now and will be getting ready for plucking. The pods are usually plucked before they are fully grown and when the seeds are just formed. Most varieties become tough and stingy if their pods are left over for long. Picking is done entirely by hand. It is important to note that when broad beans have already come to flowers, the breaking of the top end of the shoots helps to encourage proper setting of the pods. In case of artichokes the tubers will be getting ready for lifting now. The flowers should be removed as they appear and the tubers left over until required for the market, as they do not store well and there is no harm in allowing them to remain in the field. If any of the tubers get exposed, they should be covered up immediately.

Ginger and Termeric.—These will still require another month or so to be ready. Timely irrigation, weeding and mulching are the operations needed in this month.

Arum.—These may be lifted now if the leaves have turned completely yellow. The harvesting is done by cutting the leaves down to the ground and digging the ridges up either by a pickaxe or a fork. The old corm is separated from the newly formed ones which are then cleaned and sent to the market, while the former i. e. the mother corm is reserved for planting. The produce per 100 sq. ft. usually amounts to 20 lbs. The empty beds should be worked up with a fork after the usual application of the farm yard manure and made ready for the next crop.

Peas.—These having been sown in last month will now require the usual care of timely irrigation, weeding and mulching. A number of stakes should be fixed up by the side of the plants to enable them to climb up and get the necessary support.

Brinjals.—These will be fruiting freely now and the fruits may be gathered regularly and sent to the market. Weeding, watering and mulching may be continued.

Fresh plantings of tomatoes, lettuce, chillies, brinjals, peas, onions, sweet-potato and knolkohls etc., can be done in this month also. Those however, which are already transplanted will require the usual care of timely weeding, watering and mulching.

DECEMBER

Cauliflower, Cabbage and Knolkohls.—Timely irrigation and maintenance of a good mulch for the conservation of moisture form the main items of work in this month. Cabbages and cauliflowers should be earthed up, the furrows being converted into ridges and ridges into furrows.

Knolkohls should be getting ready for lifting now. These may be taken out gradually while they are still soft, as hardening of stem tends to impair its taste. In cases of attack by aphis and caterpillars, hand-picking and spraying with insecticides will be found useful.

Ginger and Turmeric.—As these crops approach maturity the watering should be reduced and as soon as the leaves begin to wither, it should be stopped altogether. The crops, however, are not harvested till February when the leaves have completely dried.

Beans.—In these the pods should be coming thick and fast now and may be gathered as soon as they are ready and sent to the market. At this time, these are liable to be attacked by aphis particularly when the weather is cloudy. Spraying with nicotine sulphate and fish oil rosin soap will be found effective.

Potatoes, Garlic and Carrots.—Timely irrigation, weeding and mulching may be done as usual.

Chillies and Roselle.—These will have finished by now and the remaining fruits may be plucked and sent to the market. The empty beds should be worked up with a fork after the usual application of farm yard manure and made ready for the next crop. In case of roselle, the fleshy calyx when fully developed may be removed for pickling. A good crop will yield about 3 lbs. of dry chillies in a plot of 100 sq. ft.

Onions.—Flowering shoots or scapes which may be appearing now should be regularly removed so as to allow the bulbs to develop properly. Hand weeding, mulching and irrigation may be given whenever necessary.

Peas.—Weeding and stirring of the soil should be continued from time to time so as to form a good mulch. Plants should be supported for climbing by means of sticks planted along the sides of the rows and so placed as to allow those of one side to interlace over head with those of the other.

Beet, Turnip, Lettuce and Radish.—These also should be ready for the market now and may be gradually removed. Timely irrigation, however, should be continued till the whole crop is harvested. Successive sowings of these may still be done in this month as well, if required.

Spinach, Coriander, Methi, Chakwat, Ghore, Chaulai, Chuka and Chandan-Batwa.—Those sown in October will now be ready for the market and may be gradually removed. The plantings of November, however, will have to be kept on and the usual care of timely irrigation and weeding continued. For purposes of a continuous and regular supply fresh sowings at intervals of a fortnight may be continued.

Brinjal, Sweet potato, Tomato and Chillies.—These are the cold weather crops transplanted in October and will require the usual care of timely weeding, watering and mulching.

JANUARY

Cauliflowers.—Blanching should be done to these now. This consists of drawing the leaves over the inflorescence, when the heads attain a diameter of 2″ or 3″ and tying them together by means of a string. This will prevent the direct rays of the sun as well as the showers from the winter rains from falling directly on the flowers and spoiling their quality, as the cauliflowers are particularly valued for their white colour without which their market value is considerably reduced. A careful watch should be kept on the condition of the field and watering should be done as soon as the land shows signs of drying up.

Knolkohls.—These should be ready for lifting now, and may be taken out and sent to the market. The plants should be pulled out when the diameter of the swollen stem reaches approximately about 2½″. The stem is paired off just below the swelling, gathered and sent to the market. Timely irrigation, however, should be continued till the whole crop is harvested.

Peas.—These will be getting ready for plucking and the well developed but tender pods may be picked. Weeding, mulching and irrigation should be continued. The leading shoots should be pinched off after the flowers have appeared, as it will tend to check further growth of the vines and feed the pods, making them well filled and heavier.

Beet, Turnip, Radish, Lettuce and Carrot.—These will be in full swing now and should be taken out as soon are ready and sent to the market. The plots which have been cleared of the crop should be manured and forked up in order to prepare them for next crop.

Onion, Garlic, Potato and Cabbage.—Timely irrigation and mulching are the only important operations in this month for these crops. In case of onions, regular removal of the flowering shoots should be continued.

Spinach, Coriander, Methi. Chakwat, Ghore, Chaulai, Chuka and Chandan-Batwa.—Those sown in November will now be ready for the market and may be gradually removed. The plantings of December, however, will have to be kept on. Timely irrigation and weeding continued as usual. The empty beds may be manured and forked up and made ready for the next crop. For purposes of continuous supply, fresh sowings at intervals of a fortnight may be continued.

Ginger.—The crop should be ready for harvesting now. Before lifting, however, the withered leaves and stalks should be cut and removed. The lifting is done by hand by digging up the ridges with a small " Kodali " or fork and picking out the rhizomes which are sold either as such or are dried and cured and sold as "sunth." The curing of ginger for the preparation of sunth is as follows. The ginger is dried in the sun for a short time and then soaked in water to soften the outer skin which is peeled, unnecessary wastage being avoided by not scraping too deep. The peeled ginger is then washed in water and spread out on a mat or any raised platform to dry in the sun for three or four days, care being taken to keep it always dry and not allow any dampness or moisture to affect it as in that case the ginger will become black in colour and loose half its value. For the first day or two the rhizomes are turned over after a few hours to ensure uniform exposure to the sun. The average yield is about 20 lbs. of fresh ginger from an area of 100 sq. ft. In the drying process this will be reduced by 75%.

Beans.—These will have finished by now and the remaining crop may be harvested and sent to the market. Empty beds may be dug up after the application of usual quantity of manure and the beds made ready for other crops.

Gourds, Pumpkins, Bhindi and Gavar phalli.—Seeds for the hot weather vegetables should be sown during the last week of this month. The land should be prepared manured, laid out and sown in the same manner as described in detail before.

Goose Berries.—These begin to ripen in this month and the fruits should be plucked and sent to the market as soon as they are ready. Weeding and irrigation should be continued till the crop is completely over.

Tomatoes, Brinjals, Chillies and Sweet-potatoes.—These being planted in October as cold weather crop will require the same care as has been described for the rainy season ones. For purposes of continuous supply fresh planting of tomato may be done in this month as well.

FEBRUARY

Cauliflowers and Cabbages.—These should be getting ready for the market in this month and may be gradually removed as they mature. The main criterion in judging the degree of maturity lies in observing the condition of the "Curd" or head formed. The heads should be removed as soon as they are ready as otherwise their value decreases if harvesting is long delayed. Over-mature heads tend to become loose. A good marketable cauliflower should be compact in appearance, white in colour and about 6″ to 9″ in diameter. These should be cut well below the heads with the sharp knife or sickle, care being taken to prevent injury to the heads while handling. This may be done with advantage either in the morning when the dew is on them or late in the evening. This will add considerably to their keeping quality and make them more tasteful.

In case of cabbages, only compact heads are to be harvested as they get ready while the loose ones may be left over for the time being to enable them to become compact. Timely irrigation should be continued till the whole crop is harvested.

Knolkohls.—These will have finished by now and the remaining crop may be removed and sent to the market. The empty beds should be worked up with a fork after the farm yard manure has been spread over them and the beds made ready for the next crop.

Peas.—These will be in full swing now and the plucking of the well filled but medium grown, tender pods should be continued, the full developed and ripe ones being left over for the seeding. Hand weeding, mulching and irrigation should be given as often as necessary, particularly the latter, as it keeps the pods tender and prevents them from ripening too early. The peas are sometimes attacked by mildew when the pods are being formed. Sulphur dusting in such cases is very effective. An attack by aphides, however, is often prevented by spraying with tobacco decoction.

Potatoes.—These should be getting ready for lifting now, as the haulms will have died down completely by now. Harvesting is done with Kodali or Fork which is inserted at the base of the ridges immediately under the plant and lifted so as to bring the potatoes to the surface of the ground. The tubers should be allowed to remain on the ground until quite dry, when they should be sorted out into table and seed potatoes and stored. The table potatoes should be covered up completely with straw to exclude the light so as to prevent them from becoming green while the "seed" potatoes are spread out on racks in a dry airy place. The average yield is about 20 lbs. of potatoes from an area of 100 sq. ft.

Turmeric.—These should be harvested in this month by lifting, after the withered leaves and stalks have been cut off and removed. A good crop will yield about 20 lbs. of rhizomes in a plot of 100 sq. ft. After the rhizomes have been cleaned and washed, they are placed in a vessel with sufficient water to just cover the whole lot. The lid is put on and the vessel is then placed over the fire and allowed to boil slowly for about 2 to 3 hours. The rhizomes are then taken out and dried in the sun for about a week. The outer skin is then removed by rubbing or treading under foot and when quite clean the rhizomes are stored or sent to the market. The crop after curing is reduced to about a 5th of its original weight.

Onion and Garlic.---Timely irrigation, weeding and mulching are the main operations necessary for these crops in this month.

Spinach, Coriander, Methi, Chuka, Chakwat, Chandan Batwa, Sapu, Choulai, Ghore and Lettuce Etc.—Those sown in December will now be ready and may gradually be removed and sent to the market. The empty beds should be manured and forked up immediately for the next crop. A fresh sowing may still be done in this month for keeping up the continuity of the supply of the market.

Cucurbits, Bhindi and Gavarphalli.—Timely weeding and maintenance of a good mulch for conservation of moisture in the soil form the main items of work in this month. For other details July notes may be consulted.

Beet, Turnip, Radish and Carrot.—The well grown but tender ones should be pulled out, cleaned and sent to the market while those that have become overgrown and hard may be left over in the beds for seeding. The empty beds that have been cleared of the crop may now be manured and worked up with a fork.

Tomato, Brinjal, Chilli and Sweet-Potato.—These being planted in October as cold weather crop will require the same care as has been mentioned for rainy season ones.

MARCH

Cauliflowers, Cabbages and Tomatoes.—These will have finished by now and the remaining crop may be harvested and sent to the market. Empty beds should be dug up after the application of manure as usual

Onion and Garlic.—These will not be ready for another month or so. Timely irrigation, weeding and mulching should be continued as usual. Regular removal of the flowering shoots or "scapes" should be attended to.

Gourds, Pumpkins, Ladies' Finger and Gavarphalli.—These being sown at the end of January will require the usual care of timely irrigation weeding and mulching. The other cases of after treatments due to incidence of disease etc., may be dealt with, according to instructions given in August notes. Fresh sowings of these may be continued for future supply as usual.

Brinjal, Chilli and Sweet Potato.—These being sown in October will be getting ready for lifting and the same instructions as detailed in notes of November should be carefully followed for harvesting the crops.

Spinach, Coriander, Methi, Chuka, Chakwat, Chandan Batwa, Sapu, Chaulai, Ghore and Lettuce.—The crop sown in January will now be ready for the market and may be gradually removed. The emp'y beds should be forked up as usual after the application of farm yard manure and kept ready for the next drop. Fresh sowing of these may still be made in this month as well, for keeping the continuity of the supply.

APRIL

Onion and Garlic.—These should be ready for lifting as the leaves will have dried completely by now and withered, indicating maturity. The bulbs are gathered by pulling them out or with the aid of a light kodali if necessary. The roots and leaves are cut off, scales removed, injured or bifurcated bulbs sorted out, after which they are sent to the market or stored in a cool place in thin layers. 40 lbs. of onion bulbs and 16 lbs. of garlic are obtained from a plot of 100 sq. ft.

Gourds and Pumpkins.—The fruits ready for plucking may be gradually removed and sent to the market. Watering, hoeing etc., should be continued as before. Successive sowings of cucurbits may be continued if required.

Spinach, Coriander, Methi, Chuka, Chakwat, Chandan Batwa, Sapu, Chaulai, Ghore and Lettuce—The crops of these sown in February should be ready for the market and may be gradually removed. The empty beds may then be forked up as usual after manuring and kept ready for the next crop. A fresh sowing may still be made in this month as well for keeping up the continuity of the supply.

Tomato, Brinjal and Chilli.—Watering and hoeing of the standing crop should be continued, till the crops are finally harvested. The other instructions regarding other operations in these have already been described and may be referred to, if necessary.

MAY

This in general is the driest month in the year. Opportunity theretore, should be taken to work up all empty beds thoroughly after the addition of farm yard manure and leave the soil exposed. The crops that should be ready now are the gourds, pumpkins, ladies' finger, gavarphalli, tomatoes, chillies, spinach, coriander, methi, chandan batwa, sapu, chaulai etc. The watering may be continued till the crops are finally barvested. Towards the end of this month the following rainy season crops like cucurbits, bhindi, gavarphalli tomato etc. should be sown. The land for these should be prepared after manuring, laid out and sown in usual way, care being taken to make the necessary arrangements for irrigation.

Artichoke tubers stored so long may now be watered lightly in the second week of this month in order to encourage sprouting, so that the plants may be ready for transplanting in the third week of June.

College and Hostel Notes

COLLEGE DAY CELEBRATIONS

The College Day was celebrated on the 9th January 1943. B. G. Khaparde Esq., M. L. A. was the chief guest, who gave an illuminating address. Other programmes included Inter-Class Matches in Hockey and Volley-ball. Two exhibition matches were held, one in Volley-ball between the present students vs. staff and past students and another in "Hu-tu-tu" between our College and the National College, Nagpur. Other sports events were keenly contested. The programme ended with an at-home.

The students were addressed by Fight Lieut; Sethna, Lieut. Shrivastava and Mr C. B. Parakh in which the lecturers pointed out the apportunities for students in War Services.

PRIZE WINNERS IN SPORTS

	First	*Second*
Three miles race	C. S. Iyer	G. D. Siriah
One mile race	S. G. Thakrey	G. D. Siriah
880 yards	G. D. Siriah	C. S. Iyer
440 yards	G. T. Saoji	S. G. Thakrey
220 yards	G. T. Saoji	M. G. Saoji
100 yards	G. T. Saoji	C. S. Iyer
High Jump	B. G. Mathias	G. N. Bhoot
Long Jump	V. D. Barve	B. G. Mathias
Shot put	S. B. Thawle	
Volley-ball Doubles	R. N. Khandelwal M. L. Purohit	J. P. Nayak P. S. Parsai
Table Tennis	P. S. Pimpalgaonkar	N. H. Sohni
Carrom Singles	R. N. Khandelwal	N. H. Sohni
Carrom doubles	N. H. Sohni P. S. Pimpalgaonkar	Y. K. Kulkarni S. G. Thakrey
Chess	B. P. Misra	M. L. Purohit

ELOCUTION COMPETITION PRIZE WINNERS

	First	*Second*
English	P. S. Parsai	D. D. Shukla G. T. Saoji
Hindi	R. B. Mandloi	P. S. Parsai
Marathi	A. M. Diwekar	G. T. Saoji

INTERCLASS TOURNAMENTS

Volley-ball	Fourth year	Captain S. N. Khutate
Hockey	Second year	,, C. S. Iyer
Foot-ball	Second year	,, B. E. Mathias

INTERCLASS RELAY RACE SECOND YEAR

1. G. D. Siriah, 2. C. S. Iyer, 3. B. G. Mathias, 4. G. D. Dubey.

	1941—42	*1940—41*
Best Sports Man	N. K. Maharanwar	R. S. Raghuwanshi
Football colour holder	R. N. Khandelwal	G. T. Saoji awarded University colour in Football 1941—42.
Hockey colour holders	R. T. Rajkonwar Trilochansing G. D. Siriah A. G. Khan	

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Editorial

The Albert Gold Medal

The decision to award the Albert Gold Medal this year, to Sir John Russel, D.Sc. F.R.S., Director of Rothamsted Experimental Station, is received with great approbation. This signal honour is conferred as the mark of highest distinction. The last two recipients are Field Marshal Smuts in 1942 and Mr. Roosevelt in 1941.

As an authority on the science and practice of agriculture Sir John Russel stands perhaps second to none of the living experts. The award is indeed a fitting recognition of his valuable contributions, coming as it does, at the time when he is retiring from the Directorship of the famous institution which is now celebrating its centenary.

The progress of the efforts in the application of science to crop-production in India is closely associated with this great authority. He visited India during 1936–37 to review the work of the Imperial Council of Agricultural Research and to recommend measures for increasing its usefulness. His suggestions in this respect are extremely valuable. His report stands in line with the Report of the Royal Commission on Agriculture, as a land-mark in the history of the improvement of Indian agriculture.

Wealth out of Waste

The problem of supplying adequate manure of proper type to agricultural land is a major problem in India. Its importance is now greater owing to the large part it plays in augmenting the country's food production and making the food-drive a success. The application of artificial fertilizers presents difficulties peculiar to the times e.g. shortage of supply and high cost. Any measure calculated to overcome the present difficulties by making available cheap and quality manure will be readily availed of.

Attention has been directed for years in the past to the feasibility of utilizing the town wastes for manurial purposes by its conversion into compost manure. The success achieved by the efforts of the eminent scientists working at the Indore and Bangalore Institutes in perfecting composting methods are worthy of note. But their path is strewn with innurnerable difficulties which may best be appreciated from the words of Dr. Gilbert Fowler the renowned authority on this subject: "Preparation of compost manure from waste materials is not a simple matter as it may appear on the surface. It involves the application of fundamental scientific knowledge, especially in relation to the transformations of carbon, nitrogen, phosphoric acid, potash and humus. This scientific knowledge should be adopted to local conditions and the process should be carried out in a manner to satisfy hygienic requirements namely the absence of smell and fly breeding, and at the same time on an economic basis so as to make the product as cheap as possible."

The Government of India have evinced special interest in this matter by sanctioning recently a grant of Rs. 2½ lakhs for introducing the improved process of composting developed at the Indian Institute of Science, Bangalore. As an initial step the necessary training is now being imparted to the deputees of various provinces and States by Dr. C. N. Acharya, Chief Biochemist, Imperial Council of Agricultural Research, at Bangalore. These trainees will be organizing a net-work of compost making stations in the vicinity of towns in their respective Provinces or States.

Time is now ripe for various Municipal Committees to become 'compost minded'. They will do well to avail of this apportunity of utilizing the services of these scientists by keeping the necessary means at their disposal. This will serve the dual purpose of improving urban hygiene and enriching the neighbouring lands and thus produce wealth out of waste.

ORIGINAL ARTICLES

Response of Unirrigated Paddy in Heavy Black Soils of the Haveli tract to Manuring with Oil Cakes

By

Dhannalal,

G. R. Sirpurkar

and

R. J. Kalamkar.

Introduction : — The response of paddy to manuring has been exhaustively dealt with by Sethi(1) and Vaidyanathan(2). Most of these experiments relate to the effect of fertilizers in different combinations under irrigated conditions. No sufficient data are available showing the results of manuring paddy with oil cakes. The economic aspect of manuring paddy with groundnut cake has been investigated by Sukhatme(3). In the light of these investigations the Imperial Council of Agricultural Research have recommended that further experiments should be undertaken to investigate the economics of manuring paddy with oil cakes on the basis of their nitrogen content and that a wider range of nitrogen doses be included.

These investigations are of particular importance in the present times, as owing to the war, considerable difficulty is being experienced in obtaining fertilizers while the problem of increasing food production is becoming more and more pressing. The cultivators of the rice and wheat tracts are advised to put as much area under paddy as possible and divert to paddy part of the heavy land hitherto reserved for rabi crops and thus converting them into dofasli. It has, therefore become all the more necessary to exploit to the full the local available manures and investigate their economic aspect.

Layout of the Experiment :— An experiment was laid out in 1942-43 at the Government Experimental Farm, Adhartal (Jubbulpore), Kheri Section, to study the effect of cakes. The layout of the experiment was randomised blocks with six replications. The treatments were three kinds of cakes viz. groundnut, linseed and til the doses of each being O, 20, 40 and 60 lbs. of nitrogen per acre, giving in all 12 plots per block, three of which are unmanured. There are thus only 10 distinct treatments. The percentage of nitrogen was 8.27, 5.51 and 5.83 in groundnut linseed and til cakes respectively.

Small bandhis 2′ high and 3′ broad were made all round the experimental plots. The gross size of the plots was approximately 1/37th acre (27′ × 44′). The ulimate size of the plot harvested was 1/80th acre (16½′ × 33′). The plan of the experiment together with the yield of grain and straw is given in the appendix.

Analysis of Soil :—The soil is heavy, black, typical of the haveli tract and was raising rabi crops only, such as wheat and pulses in rotation. The field was put under paddy for the first time in 1942-43 since the farm was acquired. The soil of the field under experiment is classified as Kabar II and its analysis is as under.

*Analysis of soil (Kheri Farm) Kabar II.

(Percentage on air dry basis).

	SOIL LAYER.		
	0″—9″	9″—18″	18″—27″
Coarse Sand	3.3	2.6	2.7
Fine Sand	14.0	12.9	12.6
Silt	21.9	20.2	22.6
Clay	51.7	58.3	57.6
Moisture	4.2	4.5	4.2
Loss on Ignition	1.2	1.6	1.3
Calcium Carbonate	0.147	—	—
Total N	0.0567	0.0525	0.0518
Total P_2O_5	0.0683	0.0708	0.0676
Available P_2O_5	0.0057	0.0052	0.0057

Cultural operations:—The plots were bakhared on 30th May 1942. The cakes were applied on 3rd June and Paddy EB.17, a medium variety was broadcast on 4th June at the rate of 100 lbs. per acre. The seed and the manure were subsequently properly mixed by bakharing. The first good shower of rain was received on 21st June 1942. Total rainfall during June amounted to 5.19 of which only 0·26″ were received by the 20th of June. July registered 22·60″, August 14·09″ and September 7.43″. The rains were continuous during the months of July and August and ceased on the 22nd September 1942. The crop received one weeding in the first week of August and was harvested on the 3rd November.

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* Kindly supplied by K. R. Sahasrabudhe, Research Student.

Observations during the growth period of the crop :— The plots were under observation during the growth period of the crop. They were first observed on the 25th June. No difference in germination was noticed in the differently treated plots. The manurial effect began to be manifest in about 12 days after germination but the differential effect of cakes was not visible till about 20 days after germination. Til cake appeared to be the quickest to act, next came linseed and groundnut stood last. A period of about 15 days intervened before linseed cake equalled til cake and another 15 to 18 days for groundnut cake to surpass the other two cakes. Paddy in manured plots came into ear earlier than in the unmanuerd ones, that in the plots receiving higher nitrogen dose coming into ears earlier than that with lower manurial doses. Plots receiving til and linseed cakes could not be easily differentiated in respect of the effect on earing. Groundnut cake at lower doses appeared to hasten earing as compared to other cakes.

Structure of Analysis of Variance : — It has already been observed that in the layout of the experiment there are, in each block, three untreated plots corresponding to each type of cake. There are, therefore,, only 10 different treatments in each block and not 12.

The structure of the analysis of variance will then be 5 d. f. for blocks, 9 for treatments made up of 3 for nitrogen quantity effect, 2 for nitrogen quality and 4 for interaction of quantity and quality of nitrogen and balance 57 for error, making a total of 71 d. f. for the whole experiment. Out of the 57 d. f. for error there are 12 d. f. for the variation of the untreated plots and the mean square due to this should be of the same order as obtained with that due to the remaining 45 d. f., if the error sum of square is not made up of heterogeneous contributions. The 45 error degrees of freedom can be further subdivided into 5 for the interaction of blocks with the yield of the control plots verses the mean yield for the remaining treatments and the balance 40, calculated by analysing the part of the experiment containing all treatments except controls as 6 randomised blocks of 9 treatments.

Sum of squares due to 3 d. f. for quantity, 2 for quality and 4 for interaction can be split up into single degrees of freedom by forming suitable orthogonal sets for comparisons.

Stastistical Analysis of the data and discussion of results:— The complete analysis of variance for grain and straw yields is given in Table I.

Table I.

Analysis, of variance of grain and straw. (In ounces per plot basis.)

Due to	D.F.	Mean-square Grain.	F:	5% F.	Mean-square Straw.	F.	5% F.
(a) 20 V 60 N	1	90501	120.4	4.02	1371631	268.0	
(b) 20,60 V 40 N	1	6211	8.3		29107	5.7	
(c) 20,40,60 V 0 N	1	218123	290.1		2336256	456.5	
(d) Quantity	3	104945			1245665		
(e) Groundnut V Til	1	756			29412	5.7	
(f) Groundnut, Til V Linseed	1	216			1657		
(g) Quality	2	487			15535		
(a) × (e)	1	400			75488	14.7	
(a) × (f)	1	1136	1.51		6235		
(b) × (e)	1	1058			3362		
(b) × (f)	1	11			6667		
Interaction between Quantity & Quality	4	651			22938	4.5	2.5
Treatments	9	35379	47.2	205	428868	83.8	
Blocks	5	6755			64344		
Error	40	842			5182		
	5	740			13677		
	45	830			6122		
	12	456			1338		
	57	752			5118		
Total	71	—			—		

It will be observed that the error mean squares due to 45 and 12 d. f. are significantly different in the case of straw but not in the case of grain. Further, the error mean square with 5 d. f. is significantly different to the error mean square either with 40 d. f. or 12 d. f. in the case of straw yields alone. The mean squares with 45 and 57 d. f. are, however, not significantly different either in the case of straw or grain yields. A combined error with 57 d. f. is taken for testing the treatment effects both for straw and grain, although for straw it would be more appropriate to base it on 45 d. f.

It will be observed from the table that both in the case of grain as well as straw, the nitrogen quantity effect is significant. The effect of quality of nitrogen on the yield of grain is not significant i. e. the kinds of cakes tried are equally effective, in increasing the yields of grain. In the case of straw, however, it almost reaches significance, the application of til cake resulting in significantly higher yield of straw than that secured by the application of groundnut cake.

The results are shown quantitatively in Table II.

TABLE II.

Average Yield of grain and straw in lbs. per acre.

		0 N	20 N	40 N	60 N	Mean	S. E.
	Grain	471	818	1182	1314	947	32.3
	Straw	1658	2680	3902	4632	3218	84.3
Percent of control	Grain	100	174	251	280	—	—
	Straw	100	162	235	279	—	—

		Groundnut	Linseed	Til	S. E.
	Grain	1136	1082	1091	32.3
	Straw	3615	3699	3900	84.3
Percent of control	Grain	241	232	232	—
	Straw	218	223	235	—

		Groundnut			Linseed			Til.			S E
		20N	40N	60N	20N	40N	60N	20N	40N	60N	
	Grain	867	1172	1370	762	1173	1343	824	1203	1245	56.0
	Straw	2853	3655	4337	2678	3974	4444	2509	4077	5115	146.6
Percent of Control	Grain	184.3	248.9	291.0	161.8	249.0	285.1	175 1	255.4	264.4	—
	Straw	172.0	220.4	261.6	161 5	239,8	268 0	151.3	245.9	308.5	—

The average yield per acre for the control plots was 471 lbs. of grain and 1658 lbs. of straw. The percentage increase over control by the application of 20, 40 and 60 lbs. of nitrogen per acre was about 74, 151 and 180 respectively for grain and about 62, 135 and 179 respectively for straw, each higher dose giving a significantly higher yield than the lower one.

As already observed, there are no significant differences in yields of grain for the different cakes tried. In the case of straw, however, it will be observed that plots treated with til cake give the highest yield of straw and the difference in yield is statistically significant compared to the yields obtained from plots treated with groundnut cake.

The interaction effects between quantity of nitrogen and kind of cake in the case of grain is not significant. It will be noted, however, that unlike the other two cakes, the application of til cakes at 60 lbs. of nitrogen per acre has not resulted in the significant increase in yield of grain over plots treated with it at 40 lbs. of nitrogen per acre. The interactions in the case of straw are significant and are shown in Table III.

TABLE III.

Interaction effects for the yield of paddy straw.

Difference in yield of staw in lbs. per acre for different kinds of cake.	Dose of nitrogen in lbs. per acre.		
	20	40	60
Til — Groundnut	— 343.3	+ *422.5*	+ *778.3*
Linseed—Groundnut	— 174.2	+ 319.2	+ 107.5
Til — Linseed	— 169.1	+ 103.3	+ *670.8*

Standard Error of difference 207.25

It will be observed that while there are indications that at the rate of 20 lbs. of nitrogen per acre, groundnut cake gives higher yield of straw, at 40 and 60 lbs. dose other cakes are superior to it. The yield differences for different cakes at the 20 lbs. dose are not, however, significant. Til cake is definitely superior to groudnut cake when applied at the rate of 40 or 60 lbs. of nitrogen per acre. It is also definitely superior to linseed cake at the dose of 60 lbs. nitrogen per acre in increasing the yield of straw. The mean grain : straw ratio for the untreated plots was 1 : 3.66. There was no significant difference in the grain : straw ratio both for quantity as well as quality; the interaction effect, however, was significant. At the 60 lbs. dose the ratio was 1 : 3.19,3.35 and 4.24. for plots treated with groundnut, linseed and til cake respectively.

Differential behaviour of til cake.—The differential behaviour of til cake as compared to that of groundnut and linseed cakes is interesting and rather difficult of explanation.

Availability of various cake manures in typical soils of the Central Provinces and Berar has been investigated by Plymen and Bal(4) but specific information in so far as it relates to the conditions in haveli tract, as under the present experiment, is not available. It has already been noted that observation during the growth period of the crop indicated that til cake was the quickest to show its effect, next came linseed and groundnut cake stood last. These observations are in general agreement with those of Plymen and Bal. The differential effect of cakes was not visible till about 20 days after germination. A period of about 15 days intervened before linseed cake treated plots equalled those treated with til cake and another 15 to 18 days before plots treated with groundnut cake appeared superior to the other plots treated with til and linseed cakes. Unlike the other two cakes, the application of til cake at 60 lbs. of nitrogen per acre has not resulted in the significant increase in yield of grain over plots treated with it at 40 lbs. of nitrogen per acre. The comparatively higher yield of straw at the dose of 60 lbs of nitrogen in the form of til cake was perhaps due to much additional tiller formation which was superfluous in the sense of not leading to additional ears and consequent increase in the yield of grain. Til cake being quick acting, much of the available nitrogen formed is perhaps washed out before it can be effectively used by the tillers for the proper development while at a later stage the available nitrogen formed in the soil is not enough to meet the requirement of the large number of tillers to form grain. It may be mentioned that the ash content of til cake is, in general, over two times that of either linseed or groundnut cake, being 12 to 16 per cent as against about 6 per cent. in the other two cakes. The potash and phosphate content of these cakes, however, do not vary much widely and is about 2 per cent of each.

The Response Curve.—In the analysis of variance table, the 3 d. f for nitrogen quantity can alternatively be split up into 1 d. f representing the linear component of the response curve, a second representing a quadratic component and the third, the cubic. The respective contributions, both for grain and straw, are shown below.

Due to	D.F.	Mean-square Grain.	F.	5% F-	Mean-square Straw.	F.	5% F.
Linear term	1	304735	405.4	4.02	3604345	72.4	4.02
Quadratic term	1	7938	10.5		15371	2.2	
Cubic term	1	2161	2.9		17278	3.4	
Total	3	104945			1245665		
Error variance	57	752			5118		

Compared to the error mean square with 57 d. f., it will be observed that most of the variation due to nitrogen response is accounted for by the linear term both in the case of grain as well as straw yield. The quadratic term is also significant in the case of grain. The cubic term both in the case of grain and straw is insignificant.

Optimum dose of manuring.— As grain is the most important economic product the yield of grain alone is considered. The determination of the optimum dose of manuring presupposes a known form of relationship between the value of extra produce and the dose of manuring applied. It has been observed that while the effect of different doses of nitrogen is significant that of kind of cake is insignificant. The relationship has, therefore, been worked out from the extra yields of grain secured over the unmanured plots due to the application of nitrogen in different quantities irrespective of the kind of cake used.

The extra yields per acre over control for 20, 40 and 60 lbs. doses of nitrogen work out to 347, 711 and 848 lbs. respectively. The relation between the extra yield and the dose of manuring is represented by the equation.

Extra yield per acre $= A + B\wp_1 . + C\wp_2$ —————————(i)

The values of A, B and C for the data under consideration are $A = +476.5$ $\quad \wp_1 = (d - \mathbf{d})$

$B = +290.8$

$C = -\ 52.5$ $\quad \wp_2 = \left\{ (d - \mathbf{d})^2 - \frac{n^2 - 1}{12} \right\}$

where d represents the dose of manuring in units of 20 lbs. i. e. $d_0 = 0$ $d_1 = 20$ lbs. $d_2 = 40$ lbs. and $d_3 = 60$ lbs. of nitrogen. $\mathbf{d}$, therefore, works out to 1.5. $n = 4$ in the data.

Equation to the cost of manure is $\text{Cost} = q.\ d$ —————(ii) where q is the cost per dose in units of 20 lbs. of nitrogen.

The money value of the extra yield is given by the equation—

Value of extra produce

$$= p\left\{ A - B\mathbf{d} + C\left(\mathbf{d}^2 - \frac{n^2 - 1}{12}\right) \right\} + p\left\{ B - 2C\mathbf{d} \right\} d + p\,C\,d^2 \text{ ——(iii)}$$

where p is the value in rupees per pound of paddy yield.

NOTE:—$\wp_1$ & $\wp_2$ *stand for the functions of the dose* d *of the 1st and 2nd degree respectively.* **d** *stands for mean dose and* **d** *stands for the optimum dose of nitrogen.*

The equation to the profit due to extra produce is

$$\text{profit} = p\left\{A - B\mathbf{d} + C\left(\mathbf{d}^2 - \frac{n^2-1)}{12}\right\} + \left\{p(B - 2C\mathbf{d}) - q\right\} d + pCd^2 \qquad \text{———— (iv)}$$

The optimum dose **d** is given by the quation

$$\mathbf{d} = \frac{q - (B - 2C\mathbf{d})}{2\,pC} \qquad \text{———————— (v).}$$

Using the above equation, the optimum dose and consequently the maximum profit can be worked out for the different levels of prices for paddy and cakes. Their standard errors can be calculated by the formulae given by Sukhatme(3). The percentage of nitrogen in the groundnut cake is taken at 8.27, in linseed at 5.51 and in til cake at 5.83.

The optimum dose in units of 20 lbs. of nitrogen in the case of groundnut cake selling at Rs. 4/- per maund and paddy at 16, 24 and 32 lbs. per rupee have been worked out by substituting the various values in the above equation. They come to 2.43, 1.50 and 0.58 units, each unit being of 20 lbs. i. e. about 49, 30 and 12 lbs. of nitrogen respectively, equivalent to the application at the rate of 7⅓, 4½ and 1¾ maunds of groundnut cake per acre.

Economics of Manuring.—The extra yields per acre over control for 20, 40 and 60 lbs. doses of nitrogen as stated above are 347, 711 and 848 lbs. respectively. Profit and its corresponding critical difference have been worked out at different combinations of prices of paddy and of manures and shown in Table IV. The three price levels for paddy taken are 16, 24 and 32 lbs. per rupeee and of cakes at Rs 2, 3 and 4 per maund. The last column in the table gives the critical difference, and when the profit exceeds its corresponding critical difference it is considered to be statistically significant.

It will be observed from the table that the profits are, in general, more when the cakes are applied at the rate of 40 lbs. of nitrogen per acre, as compared to the profits obtained when applied at 20 or 60 lbs. of nitrogen. With cakes selling at Rs. 4/- per maund and paddy at 16 lbs. per rupee, significant profits are obtained only in the case of groundnut cake applied at 40 and 60 lbs. dose of nitrogen and Til cake applied at 40 lbs. dose. At the above prices, groundnut cake applied at 40 lbs. per acre i. e. about 6 maunds per acre gives the highest profit of over Rs. 20/- per acre as against Rs. 8/- in the case of linseed (about 9 maunds per acre) and Rs. 10/- in the case of til cake (about 8.3 maunds).

The table clearly brings out at what rates of paddy and oil cakes, manuring is economic or otherwise.

Summary and Conclusion.

The economic aspect of manuring paddy with oil cakes under unirrigated conditions in the heavy black soil of the haveli tract has been investigated. The important conclusions are :—

(1) Both in the case of grain and straw the nitrogen quantity effect is significent, each higher dose giving significantly higher yield than the lower one.

(2) The average yield per acre for the control plots was 471 lbs. of grain and 1,658 lbs. of straw. The percentage increase over control by the application of 20, 40 and 60 lbs. nitrogen per acre was about 74, 151 and 180 respectively for grain and about 62,135 and 179 respectively for straw.

(3) The different kinds of cake viz. groundnut, linseed and til were equally effective in increasing the yield of grain but unlike the other two cakes the application of til cake at 60 lbs. of nitrogen per acre has not resulted in significant increase in yield of grain over plots treated with it at 40 lbs. of nitrogen per acre.

(4) In respect of the yield of straw, til cake is definitely superior to groundnut cake when applied at the rate of 40 or 60 lbs. of nitrogen per acre. It is also definitely superior to linseed cake at the dose of 60 lbs. nitrogen per acre.

(5) This differential behaviour of til cake as compared to that of groundnt and linseed cake is suggested to be due possibly to the fact that it was the quickest to act and much of the additional tiller formation was superfluous in the sense that it did not lead to additional ears and consequent increase in the yield of grain. Much of the available nitrogen formed is perhaps washed out before it can be effectively used by the tillers for their proper development while at a later stage the available nitrogen formed in the soil is not enough to meet the requirements of the large number of tillers to form ears.

(6) Observations during the growth of the crop indicated that manurial effect manifested itself in about 12 days after germination but the differential effect of cakes was not visible till about 20 days after germination. A period of about 15 days intervened before linseed cake equalled til cake and another 15 to 18 days for groundnut cake to supersede the other two cakes.

(7) Paddy in manured plots came into ear earlier than that in the unmanured ones, that in plots receiving higher nitrogen dose coming into ear earlier than that with lower manurial doses.

(8) The relation between the yield and dose of manuring appears to be adequately representated by a curve of the second degree.

(9) At the current rate of 16 lbs. of paddy per rupee and Rs. 4/- per maund of cake, application of 40 lbs. dose of nitrogen in the form of groundnut cake (about 6 maunds) per acre gives the maximum profit of about Rs. 20/- per acre as against Rs. 8/- in the case of linseed (about 9 maunds per acre) and Rs. 10/- in the case of til cake (about 8.3 manunds). Groundnut cake contains 8.27 per cent of nitrogen as against 5.51 in linseed and 5.83 in til cake.

(*Table VI on page 15, and Appendix p. 16*)

Acknowledgment.

Our thanks are due to J. C. McDougall, Esquire, C. I. E, I. A S, Director of Agriculture, Central Provinces and Berar, Nagpur, for giving the necessary facilities, and to Mr. S. L Tiwari, Farm Superintendent, Adhartal (Jubbulpore), for helping in conducting the experiment.

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Gleanings

Formula For Forecasting Frost.

Considerable damage is caused to 'rabi' crops by frost in Northern India every winter. It has, however, been found that the minimum temperature, on which the occurrence of frost depends, is related with the dry and wet bulb temperatures recorded on the previous afternoon.

The equations showing these relationships depend on local factors and vary from place to place and from season to season. Indian meteorologists have analysed these data for particular places and have worked out simple equations for forecasting frost at Lahore, from the dry and wet bulb temperatures recorded there on the previous afternoon. Similar equations have been worked on for Jaipur.

These equations are given in Scientific Note No. 92, Volume VIII, published by the Meteorological Department.

(Extract from the Indian Information, Vol IX, No. 79 September 1941).

Producing Dried Potatoes.

Sometime ago it was announced that sucessful experiments were in progress on the production of dried potatoes by a special process invented by an Indian.

The dried potato possesses two advantages over the ordinary potato.

Firstly, the latter is exceedingly bulky and there would be a considerable saving in transport; secondly, the normal potato is very perishable and allowance of as much as 100 per cent has often to be made for wastage, so that, where one ton of potatoes is required, two tons frequently have to be shipped; the perishability of the dried potato on the other hand is for practical purposes almost nil.

As a result of these experiments dried potatoes are now being produced in considerable quantity in India and their production is rapidly expanding. Such is the saving in bulk, when properly packed, as to amount to almost as much as the wastage formerly incurred with the potato.

(Extract from the Indian Information, Vol. IX, No. 75, July 1941).

How to save Stored Grain from Damage by Insect Pests

By

K. R. Sontakay and P. M. Ingley.

All the countries of the world directly or indirectly involved in the present world-war are faced with the problem of adequate food supplies. India is not so hard hit as many other countries but even here the problem has assumed paramount importance. The food supply does not only depend on greater yield but also on the prevention of any waste. The question of storage of grains free from damage must therefore be tackled by every citizen. The greatest damage to food grains during storage is caused by the insect pests. An attempt is therefore made in this article to give an account in popular language of the important pests of stored grains i. e. *juar*, rice, wheat and pulses together with their preventive and remedial measures.

1. **Calandra oryzae** is commonly known as the rice weevil. It is called *'Ghun'* in Hindi and *'Sonda'* in Marathi. The insect is about 3.5 mm. long, dark brown or black in colour having a prominent snout. It is the most serious pest of all stored grains and attacks sound grains. Both the larvae and the adults cause damage but the latter are very destructive.

2. **Rhizopertha dominica** known as the borer beetle. In some places it is called *susri*. The larva feeds curled up in the grain and the adult comes out of the grain by making an irregular hole. The adults do more damage than the larvae. This is a small, slender insect about 2.5 mm. long and dark brown in colour. In dark dingy godowns this insect flourishes best. This is also a serious pest of *juar*, wheat and rice.

3. **Trogoderma khapra** is commonly known as *khapra* or *khapri*. It is 2–3 mm. long, brown in colour and stout in build. The larva of the insect is hairy and brown in colour. It is responsible for damage and not the adult. This is particularly a serious pest of wheat but sometimes may be found in *juar*. It is not known to attack rice. *Khapra* larvae are inactive during winter.

4. **Tribolium castaneum** is commonly known as the red grain beetle. It is about 3-4 mm. long, reddish brown in colour and is flattened and oval in outline. It is a bad pest of *atta* and

prepared cereal foods. It generally attacks only crushed and already damaged grains. Both the larvae and the adults do damage. It is a pest of *juar*, rice and wheat.

5. **Sitotroga cerealella** is commonly known as the grain moth. It is the caterpillar of the moth which causes damage. It is chiefly a pest of rice and *juar*. The moth is small, dry grass coloured with narrow wings fringed with small hairs. The larvae are whitish in colour with yellow head. They feed on the grain and make silken webbings with grain particles sticking to it.

6. **Corcyra cephelonica** known as the rice moth is pale greyish brown in colour and is bigger than *Sitotroga cerealella.* It flourishes in rather humid climate. Its dirty white larvae live in gallaries made up of silk, powdery matter and loose grain all jumbled up in a mass. This is mainly a pest of rice but also attacks jowar.

7. **Laemophloeus sp.**—This is a very small beetle of reddish brown colour with long antennae or feelers and is found actively moving about particularly in waste flour and spilled grain. Along with it is also found the saw-toothed bettle which looks more or less like *Laemophloeus.*

8. **Mites**--There are several mites which also damage grain and their products. Severe infestation by mites is always accompanied, if it is not preceeded, by the deterioration of the grain by insects. Apart from the actual damage, mite infestation gives an unpleasant smell to the grain in store. These are very minute creatures mainly found in the waste flour of the stored grain.

9. **Bruchus analis** and **B chinensis**—The pulse beetles. These beetles are serious pests of pulse seeds. The eggs are glued to the grain and the larva on hatching bores into the seed and feeds on its contents. When full grown, it pupates inside the seed and the adult emerges by cutting out a circular hole in the seed coat. The beetle is about 5 mm. long with a swollen abdomen.

Sources of infestalion are: (i) Infested godowns where grain was stored previously; ii) Infested grain kept in the neighbourhood and (iii) infested gunny bags.

The problem of insect-free storage of grain, therefore, resolves itself into two factors:—(i)The grain to be stored should be made free from all stages of insects; (ii) should remain free from reinfestation during storage.

To achieve both these aims, the best method is to fumigate the grain by a lethal vapour so as to kill the insect in all its stages i. e., the egg, larvae, pupa and the adult and then to storé it in insect-proof receptacles. The fumigants commonly employed are hydrocyanic acid gas and carbon bisulphide but the application of both requires a high technique and because of the dangers involved it is advisable to carry out the operations only under the supervision of an expert. A safe fumigant is 'chlorasol' which is used at the rate of 4 ozs. for 15 cubic feet of space. In terms of quantity of grain the dose is 2 lbs. for 25 maunds. The grain to be fumigated should be placed in an airtight contrainer, any cracks or openings being closed with mud. Fumigations should be carried out in the evening when the outside temperature is 70°F to 100°F. The fumigant should be sprayed or poured on to the grain directly. After pouring in the fumigant, the mouth of the container should be closed tightly and any chinks plastered with mud. The container is kept closed for 24 to 36 hours after which the mouth is opend and free aeration allowed for a few hours. The grain is then transferred to insect proof receptacles or containers. Fumigation by chlorasol though less dangerous than the hydrocyanic acid gas or corbon bisulphide fumigation, it is necessary that the fumigator should avoid inhaling concentrated vapour for any appreciable period or else it will make him seriously ill.

It is however difficult to have the insect proof receptacles and even chlorasol may not be available in quantity. In the circumstances, we have to resort to cheap and practical measures to keep the insect damage to a minimum.

One simple method is to use mercury which helps in keeping down the stored grain pests infesting earthen or metal bins. Owing to its effectiveness, comparatively low recurring cost and ease of application, this method is very well suited for household storage. Mercury is used at the rate of 3 to 4 *tolas* per maund of grain. It is applied in twill or long cloth bags each measuring 2" by 2" and containing about one *tola* of mercury. These bag are distributed in the receptacle in such a way that the upper 10" to 12" layer receives about 45 per cent of it while the remaining quantity is uniformly distributed in the rest of the receptacle. The receptacle is then made airtight. The mercuty bags can be used for many years and it has no deleterious effect on the eating quality of rice.

In the case of pulses which are attacked by two species of beetles, it is recommended that full grain or seeds should not be stored but they should be reduced to the pulse condition in which they can be kept in any available container, as little damage by pests accrues in this condition If, however, it is desired to preserve full grains, it is suggested that a layer of sand about three inches in thickness, should be spread at the top, so that the pulse beetles, if any, will come to the surface and remain there, They cannot work their way back into the grain on account of their peculiar body structure.

Before storing, the grain should be disinfected by exposing to the sun during April or May for a couple of days so as to destroy all the stages of the insect. If it is desired to store in any other month, exposure for a longer time is needed in very thin layers over cement or stone flooring. The insects. die of heat. Exposure in the cold season is not so effective as the grain does not receive adequate heat to affect the viability of insects. The method of sun-drying cannot be used in the case of rice.

All grain after disinfection whether by sun-drying or fumigation should be stored in airtight containers. The tin bins *dholi*, *bakhari* or the *peo* system (underground pits) are quite good and advantage of these, wherever available, should be taken. But where this is not possible other measures mainly consisting of werehouse hygiene should be adopted. The following are the important points.

1. There should be ample ventilation in warehouses and stores. They should be absolutely dry. Damp and dingy godowns should be discarded.

2 (a) Before storing the grain, all parts of the granary should be swept thoroughly clean. Cracks and crevices should be plastered or cemented up.

Where the store room is badly infested the best way to disinfect it is by superheating after thoroughly cleaning it. Superheating is done by burning 7 seers of charcoal for 1000 cubic feet of space. The following proceedure should be adopted.

The wall and the ceiling of the room should be swept clean. Afterwards the ventilators and other chinks and openings of the room should be closed carefully so as to make the room airtight. Temporary brick furnaces with an iron grating or a few iron bars in them should be constructed in the room and in these furnaces charcoal at the rate of 7 seers per 1000 cubic feet of space should be burnt. When the temparature of the room has risen to 150°F, the door should be closed completely and made airtight by applying mud to the chinks and openings in it. The treated store room should be left undisturbed for 48 hours after which it should be opened and allowed to cool.

(b) Even after storing the grain, regular sweeping of the floor is essential and no spilled grain should be allowed to remain.

3. A space of at least 2′ wide should be allowed between two consignments. Sacks should not be stored against walls but a space of 2′ should be left. These precautions will enable regular inspection of sacks for insects.

4. Before storing the grain, it should be thoroughly dry. Fresh grain should not be stored mixed with the old grain or even separately in the same room or in a store adjacent to an infested godown.

5. Bags, their seams and tops should be examined for pests at regular intervals.

6. If infestation is seen and threatens to be serious it is advisable to store the grain in bulk and not in bags. The general tendency of the pests is that they come to the surface. Occasional screenings of the top layers will remove most of the insects. In the case of *khapra* larvæ, covering the grain (wheat) with a rough cloth is found very useful as a large number of them will be found clinging to it. The cloth should be removed every alternate day and shaken over kerosenised water. Other insects will also be found crawling along the walls which should be collected and destroyed.

7. Infested grain, wheat and jowar, should be exposed to the sun in thin layers whereby many insects will be killed.

8. After the removal of a consignment, the floor should be swept clean. Grain is often spilled from bags and unless it is immediately removed it finds its way into cracks and crevices and supplies food for insects. Scrubbing the walls and the floors will remove the hiding insects remaining in the uneven surface. The refuse should be burnt and not heaped up outside or near the godowns.

9. An additional precaution is to whitewash the godowns, mixing some alum (1 to 3 lb. per 50 gallons) with the whitewash and scrubbing the floor with carbolic acid (5 per cent) or phenyl.

10. If there is infestation by mites, the floor should be washed twice with a solution of soda in water in the proportion of 1 lb. of soda to 1 gallon of water at an interval of three days.

11. Ventilators should be kept open for free æration except on rainy days.

12 Used empty sacks are a source of infestation and they should be kept in an isolated shed.

N. B.:—In writing the above article free use is made of the articles and papers on the subject that have recently appeared in the Indian Journal of Agricultural Science and the Indian Farming by Dr. H. S. Pruthi, Imperial Entomologist and Dr. Khan A Rahman, Entomologist to the Govt. of Punjab.

Preservation of Fruit Juice

By

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Calamities are sometimes looked upon as Nature's hard way of teaching us a lesson. It is often a blessing in disguise. War conditions have made transport not only difficult but well nigh impossible. India annually imports lacs of rupees worth of foreign drinks. As a result of the present war time conditions, it has become necessary to make an effort and see if we could utilise our own resources and manufacture drinks from the materials available locally. Hence this article will deal on the various aspects of drinks, give recipes for popular use and convince people of the healthfulness and benefits from the use of such drinks.

Need for drinks.—The wastes of our body are eliminated through the kidneys and skin. The waste material must be dissolved in a liquid form. The need is greater in summer because we lose a great amount of water from our system by way of perspiration. Thirst and a feeling of exhaustion are the result. To maintain the balance the loss of water from the system has to be replenished. We must, therefore, drink some kind of beverage. Naturally one might ask as to what would be the best form of that beverage.

There are so many beverages on the market today that are definitely harmful and it will be well to mention these so that one could avoid them intelligently. In this list of harmful drinks we find alcoholic beverages, coffee, tea, aerated waters and artificial syrups.

The facts concerning the harmfulness of alcohol have been brought to our notice a number of times in health journals and also by scientific evidence. It is unnecessary to repeat them here. Let us, however, point out here that when the alcohol in the blood reaches a concentration of only one tenth of one percent, the heart is suddenly called upon to do more work, while its capacity to do the work is lessened. This action on the heart and the circulation is only one of the many deleterious effects on the body that result from even such a small concentration of alcohol in the blood.

Many are rapidly acquiring the habit of preparing themselves for the day's work, or, of getting an extra "lift" by drinking caffeine-containing beverages such as coffee, tea etc. served in hotels and homes. These people are using unnatural physiological whip—buying temporary relief from the sensation of fatigue. These caffeine-containing drinks raise blood pressure, affect the rate of heart beats, stimulate the activity of kidneys, make appetite dull, and disturb the natural sound sleep by stimulating certain brain centres.

Aerated waters and artificial syrups which are popular cheap beverages, although they contain no harmful drugs, can not be considered amongst healthy drinks. They contain carbonated water, artificial colours and essences, sugar and sachrine, and citric acid. None of these materials have any health giving properties.

Although, we are confronted with a large market of unwholesome drinks, yet it is encouraging to note that the general public is becoming more and more health conscious, so that today drinks in the form of—fruit juices, squashes, cordials, etc. are becoming extremely popular.

Fruit drinks are unquestionably indispensible in our diet because of (1) their vitamin content, (2) their mineral salts which are alkalising, (3) their digested and assimilable carbohydrates, (4) their laxative properties, (5) their inviting pleasant flavour, (6) Their definite appetite stimulation. These drinks possess all the above properties without any substance harmful to the body. The above beneficial results are due to the fact that fruits contribute to the diet—vitamins A, B and C, fruit sugar, fruit acids, Cellulose (bulk), water, minerals—e.g. calcium, phosphorus, iron, and alkaline salts.

If you are troubled with dental caries, bleeding gums, premature wrinkles, sallow complexion, exhaustion on slight effort, fleeting pains in the limbs, irritability and weakened resisting power for diseases, you can rest assured that you are not obtaining your daily requirements of vitamins—specially C.

Lemons, oranges, grape-fruits, jambuls, mulberries, mangoes, tomatoes will supply all the requirements of the body in the form of healthful beverages.

Now that we are in the midst of a season in which it is so easy to obtain fruits cheap for healthful beverages, let us not miss an opportunity of using them abundantly for the sake of our health. It will be a weapon for war and a problem for peace. If you learn to preserve now, you will enjoy delightful and refreshing drinks on summer evenings and these drinks will add to your menu and will help to your health. They are Nature's prescriptions.

Methods of Preservation.

Lemon juice (Chemical process).

1. Extract juice, strain it,
2. Weigh the juice and add Potassium Meta bi-Sulphite in the proportion—One fourth tola for 5 seers juice.
3. Fill in sterilised jars and keep it in a cool dark place.
4. If clarified juice is required, decant the liquid after 15 days when sediment settles down.
5. Fill in sterilised bottles, cork, store in cool dark place.

NOTE.—International food regulations permit the use of Potassium Meta bi-Sulphite in the above proportion.

TOMATO JUICE.

1. Select ripe sound fruits and wash them.

2. Cut fruits and boil on a slow fire without adding water. It should be done in an alluminium pot or in an earthen pot.

3. Boiling should be continued for half an hour till fruits become very soft.

4. Mash thoroughly through a sieve (net cloth is preferable) until only skins and rinds remain.

5. Fill in sterilised bottles.

6. Pasteurise the juice at the boiling point for half an hour.

7. Cork the bottles.

Note:—This juice can be used for making tomato sauce, jelly tomato (cock tail) as a drink.

BLACK-PLUM JUICE

(*Jambol*)

1. Select ripe sound fruits and wash them.

2. Smash fruits with hand and boil on a slow fire.

(Fruit juice of the best quality can be extracted without boiling, but in order to ensure better extraction fruit should be boiled.)

3. Strain the juice through a coarse cloth.

4. Fill in the sterilised bottles.

5. Pasteurise the juice at 80° C for 30 minutes.

6. Cork the bottles and seal them with melted paraffin wax.

7. It there is no thermometer, raise the temperature of the water bath to boiling point and allow bottles to stay in water for 30 minutes, and cork them.

Note:—Juice of this fruit can be expressed and bottled for market. It also makes an excellent pink jelly. Its juice is a good medicine for diabetic patients. It can be used for vinegar making.

LEMON SQUASH.

1. Wash the fruits and extract the juice in juice press.

2. Strain the juice to remove the coarse pulp and seeds.

3. Weight the juice in Lbs.

4. Keep the bottles and corks for sterilisation.

5. Weigh out the following proportions of sugar, water and juice.

Lemon Juice	... 10 Lbs.
Water	.... 2 Lbs.
Sugar	.... 20 Lbs.

6. Mix water, sugar and juice in the above proportions and stir well till suger is completely dissolved in cold state.

7. In order to improve the flavour 4 per cent thoroughly ground and strained peel emulsion of the fruits employed for juice extraction is added to the squash.

8. Add the presrvative, Potassium Mata bi-Sulphite in the following proportion.

10. Lbs. of Juice	....One Fourth Tola of Potassium Meta bi-Sulphite.

9. Fill in the sterilised bottles.

10. Add little juice sacs to every bottle and cork them.

11. Seal them with melted paraffin wax and store them in a cool place.

Note:—Boiled water should be used. If suger takes a long time to dissolve, heat the solution to lukewarm stage only. If you have a thermometer, heat to 45°C.

ORANGE SQUASH.

(*Chemical Process*)

1. Cut Oranges into halves and extract the juice.

2. Strain the juice to remove the coarse pulp and seed.

3. Weigh the juice in Lbs.

4. Keep the bottles and corks for sterilisation.

5. Weigh out the following amounts of sugar, orange juice, and citric acid.

Orange Juice	1	Lb.
Sugar	1½	Lb.
Lemon juice	¼th	Lb.

6. Mix orange juice, sugar and lemon juice in the proportions given above, in cold state.

7. In order to improve the flavour 4 % thoroughly ground and strained orange peel emulsion of the fruits employed for juice extraction is added to the squash.

8. Add Potassium Meta-bi Sulphite in the following proportion—

For 10 Lbs of orange & Lemon juice, One Forth tola of Potasoium Meta bi Sulphite.

9. Stir well and fill in the sterilised bottles and cork them.

10. Seal them with melted paraffin wax and store them in a cool place.

Note:—Instead of cirtic acid, lemon juice in the proportion of 1 to 3 may be added (One Fourh Lb. lemon juice and Three Fourth Lb. Orange Juice).

MANGO SQUSH.

(*Raw Mangoes*)

1. Wash the fruits and peel.

2. Cut into small pieces and weigh them.

3. Add sufficient water to cover the pieces and boil for half an hour.

4. Strain the juice through a coarse cloth.

5. Weigh the following proportions of sugar & juice.

Mango juice	.... 1 Lb.
Sugar	.... 2 Lbs.

6. Add little saffron for colouring the squash and little cardamom powder for flavour.

7. Add the preservative Potassium Meta bi Sulphite in the proportoin of juice i. e. One Forth tola for 10 Lb. of juice.

8. Fill in the sterilised bottles and cork them and seal them with melted paraffin wax.

9. If preservative is not to be added, pasteurise the squash at 80° C for half an hour and cork as in the case of lemon juice item 8, Experiment No. 1

10. Mango syrup can be made according to the method of of Lemon syrup.

Researh and Instruction.

The Provincial Village Uplift Board, C. P. and Berar has its own fruit canning and preserving research labouratory where experiments are made to preserve juices and fruit products and turn them into healthful beverages. The Board has been conducting training classes since 1939 and imparting theoretial and practical instruction free to ladies and gents in the above subject. Mr. N. K. Kukde, B. Ag. (Bom) has also his own well-equipped fruit canning and preserviing laboratory where similar useful work is done. Who can estimate what the dividends have been and will be in the form of vibrant, radiant health as a result of the increase in the consumption of fruit drinks in homes; and outside due to the pioneer work of the Provincial Village Uplift Board since 1939?

For further information regarding the preservation of fruits and fruit products, please consult the Village Uplift Organiser, C.P. and Berar, Nagpur or obtain from him the book 'Preservation of fruit porducts' written in Hindi, English, Marathi and Telugu.

The Cultivation and Marketing of Papaya

By

R. A. Ramaya Esq., L. Ag.

(Botanical Name—*Carica Papaya* belonging to Natural order *Passifloraceæ*)

(Local names—Papaya, Papeeta, Papaw)

The original home of Papaya is said to be the tropical parts of Brazil in South America. From there it has reached gradually to India after its spread to Singapur, Penang, Phillippine islands, Malaya, Strait Settlements and Ceylon. It is being grown in India for the last 300 years and is said to have been introduced by the Portuguese. It is now well known and appreciated throughout this country. In India, best Papayas are grown in three places, in order of their merit—Bangalore, (Mysore State), Ranchi, (Hazaribagh, Bihar), and Gouhati (Assam). The popularity it enjoys is due to (i) the rapidity of its growth and fruiting, (ii) its adaptability to grow with little attention in different kinds of soils that are not waterlogged, (iii) the large size and good quality of the fruit, (iv) its less susceptibility to insect pests and disease, (v) the heavy crops that are borne.

Climatic and soil Requirements

Papaya is best grown in places which have warm and dry climatic conditions. This does not necessarily mean that it cannot be cultivated in other places. The only difference being that fruits ripen unevenly in the cold season and the ripened fruits of this season will not be so very tasteful as those ripening in other seasons.

Papaya can be grown in almost any kind of soil, provided it is not water-logged. It thrives best on rich loamy, medium black alluvial soils. It also does very well on red sandy loams. DOMATTA soil of C. P. is quite good for Papaya. As far as possible, the site selected should be an open one, free from the shade of large trees, and well drained. A little high lying land is preferable. Even poor sandy soil will do well if it is copiously manured.

Cultivation

The land selected for cultivation of Papayas should be given a good ploughing with monsoon plough during the rains, preferably green—manuring the land with sann-hemp. During winter any leguminous crop can be taken and the laying out for digging pits should be done during April.

Seed

Seed used for sowing should be of good quality, without any cut or injury, and should be selected from well ripe fruits. Seeds undoubtedly provide the best method of propagating Papaya.

Sowing Nursery Bed

Nursery may be put in pots, boxes or in seed beds according to one's requirement. Nursery bed should be prepared in a semi-shaded place by digging the land and breaking the clods in order that a fine pulverised soil may be obtained. Well-rotted farmyard manure mixed with cowdung ash should be added to such finely prepared seed bed and should be well-mixed with the soil. The seed bed being ready, seeds should be sown into holes made by thrusting a pencil or stick to a depth of half an inch and about two inches apart. After sowing, the seed, holes should be covered by sprinkling finely sifted manure and the surface soil should be pressed down firmly. Shade should be provided till the germination of the seed, which takes about two weeks. Judicious watering should be done every evening with a watering can having fine holes. The best time to sow seeds under C. P. conditions is the end of April and the beginning of May, since seeds will germinate well under warm soil conditions prevalent at that time and develop into young trees ready for planting in permanent positions early in the rainy season. These will bear good and delicious fruits at proper time in the very year of planting.

Seedlings

When germination is in progress, some more seed beds should be well prepared by adding requisite farmyard manure for transplanting the young seedlings when they attain a height of four to five inches. Before transplanting, both the original seed bed containing the seedlings as well as the new seed beds that are going to receive the seedlings should be copiously watered. This will ensure proper root fixation after transplanting. The plants should be spaced about 12 inches apart to allow air and sunshine to reach them and to encourage sturdy growth during the hot weather. Bottom leaves of the seedlings should be plucked leaving only the top crown. Shade should be provided from the afternoon severe sunshine, giving at the same time the benefit of the morning sun. Watering should be done according to requirement. Dense shade is never permissible as this tends to produce thin, lanky plants with little stamina.

Laying Out A Plantation

In an ordinary private garden, the papaya is usually grown in the vegetable garden. A line of trees along a boundary looks quite well, while when planted on each side of a path to form an avenue, they add a note of distinction and beauty to the vegetable garden.

In commercial plantations the trees are planted in the whole field, selected for the purpose, leaving foot-paths, so that each part of the plantation can be reached without difficulty. On one acre 410 trees can be planted 10 feet apart, leaving enough room for a path of 200 feet long and 10 feet wide.

The water channels should be placed between the lines of trees and not along the lines. One channel will thus serve two lines of trees. From the main channel are laid out small cross channels leading to the basins or ' thalas '. The advantage of this method is that each tree will receive an even water supply which is not possible if the channels are laid along the line of trees, since the basins or 'thalas' really form part of the channels.

Papaya plants are also very useful for interplanting in young plantation of other fruit trees. Being very quick growing and short lived they will have borne their crop of fruits by which time they are required to be cut out in about four years' time, before the permanent fruit trees have grown sufficiently to require the room the papaya trees occupied.

Preparing Pits For Planting and Manuring

The best time to start digging pits is early in the hot weather. Pits should be dug at a distance of 10 ft. each way, of dimensions 2'x2'x2'. While digging the pits, care should be taken to keep the top 9" soil layer on one side of the pit and the bottom sub-soil layer on its opposite side. While filling the pit, the pit should be filled in the same order, thus having the top layer of soil at the top of the pit. The soil dug out from the pit should be left exposed to the weathering agencies for a period of two months and the pit also exposed to sun shine. Shortly before the rainy season is expected to begin, i. e., say in the beginning of June, the pits should be filled in the following order. At least one pound of bone manure should be spread at the bottom of each pit, then one basketful of sand and thirdly the dug out sub-soil should be mixed with two basketfuls of well rotted farmyard manure. This mixture of soil and manure should be filled in the pits in layers of 6 inches, trampling the contents thus filled every time when it is filled to that depth. This process should be continued upto 6 inches from the top, which space should be left for watering. Finally, the top soil layer is mixed with one basketful of farmyard manure and the same is filled to ground level and then trampled down to consolidate the soil. This consolidation of the soil is very important. If the soil is not thoroughly consolidated before the trees are planted, the sinking that will take place afterwards is liable to be very detrimental to the trees. The planting may be done in square system and plant to plant distance should be 10′. Supposing ABCD is a field where in Papayas are required to be planted. Fix one peg at each corner i. e. No. 1 and No. 2. Beginning from one corner, fix pegs at a distance of 10 feet apart. By this, the plants at the end lines will have enough space to spread their branches within the field boundary. When peg number 1 and 2 are fixed, then tie strings from one end of peg. No. 1 to its own opposite side. After this join the two sides of peg No. 2 with a string. The intersecting points of the strings will be the centres of the pits. With this as centre, place the two feet square, make the necessary mark and dig pits. Continue likewise by shifting the string of peg No. 2 from one peg to the next. Let these pegs be in their position till the trees are required to be planted. During the rains, before the trees are planted, the field is required to be ploughed. After this ploughing, it will be difficult to find out the pits at the time of planting the trees. But if the end pegs are in their position, it will be easy to find out by tying the strings to peg Nos. 1 and 2. The intersecting points of the lines will be exactly the centre where in the trees may be planted. By adopting this method, the trees will be in a straight line and at equal distances.

Planting

Planting can be done at any time during the rainy season or in February, but the best time is in July, two or three weeks after the rainy season has started and the ground has cooled a little. The plants should be dug out when they are about 20″ high without disturbing the roots. Two or three days previous to planting in pits, the bottom leaves of the plant should be nipped leaving only the top crown with two surrounding leaves. This will reduce transpiration till the roots set. Some soil should be removed from the centre of the pit making a cavity a little larger than will be required to take the ball of earth round the roots of the tree. Care should be taken that the plant is placed in an upright position, and that the top of the ball of earth is just level with the surrounding earth. The soil should then be filled in, round the ball of earth and firmly pressed down after which watering should be done. It is most important that the plants should not be planted lower than they have been growing in their original place. It is also bad planting for the ball of earth to be higher than the surrounding earth and so partially exposed. The soil in the pit after planting should be trampled down and made very firm and then copiously watered.

If one is not able to have plants ready for planting in the pits during July, it is advisable to put two or three seeds directly in the pits filled for the purpose. After germination, one plant is allowed to remain and the rest are removed. Temptation to retain more vigorous ones should be overcome, and as a rule, it is always safe to retain less vigorous ones and remove more vigorously growing plants, since the latter in a majority of cases turn out to be male plants.

After Care

After planting, subsequent attention consists mainly of watering and weeding. After copious watering during planting, no watering should be done for the next 5 or 6 days, only the top soil should be stirred the third day after planting in order to prepare a mulch. When the plants have started into active growth, watering may be done as freely as may be convenient. No definite rule can be laid down regarding the number of times a week or a month that a tree requires watering. This will depend on soil and weather conditions. A good plan is to water whenever the upper 2 or 3 inch layer of soil is found dry. A day or two after each watering, mulching and weeding should be done by stirring the soil with a "khurpi". This ensures moisture retention, keeps the plantation free from disease, and will be a definite benefit to the fruit trees by improving the general appearance of the plantation. It should always be borne in mind that earthing round the plant is necessary during rains so that there may not be water logging near the plants. An open drain to take away excess rain water will be highly beneficial. The plants are injured by strong winds and should therefore be sheltered by growing border plants..

Sex Problem

Three kinds of flowers are produced—the male or the staminate, the female or the pistillate, and the perfect or the hermaphrodite. Of the fruiting kinds, the last named is preferable to female as it is usually sweeter and better flavoured—the particular point being its aptitude for reproduction true to seed than the female. Both the female and hermaphrodite flowers are produced in the axil of the leaves and usually have very short stalks. The male flowers are borne in clusters in long pendulous bunches with sweet fragrance. As far as actual fruiting is concerned, trees bearing male flowers are of no value. If the gardener can, by selection, have trees bearing only hermaphrodite flowers, there will be absolutely no need to retain male flowered trees as the former are self-pollinated having both stamens and pistils in the same flower. If the gardener has female trees, then, it is necessary that there should be in the garden at least one tree bearing male flowers for every 30 or 40 female trees, in order to effect pollination. Superfluous male trees should be cut and replaced by other trees which should be kept ready by transplanting beforehand surplus seedlings into pots of 10 or 12 inch size.

There are different ways of fruit formation in Papaya. In some, number of fruits are formed in a bunch; some form fruits in triplets, some have one or two fruits in a bunch and some others form fruits here and there. By close formation of fruits there will not be enough room for all of them to develop propely. If all are allowed to remain, the size of the fruits will be small and of irregular shape. When too many fruits are produced it is desirable and necessary to remove some of them so that those that remain many have sufficient room for proper development. This "thinning" as it is termed should preferably be done while the fruits are quite small and should be continued as long as fresh fruits go on forming. Maximum number of fruits that should be left to develop should not exceed more than forty good and well-sized fruits in one season. When a tree is made to branch by cutting the stem, only sixty fruits should be allowed to remain in its three branches put together.

Securing Regular Crops

When the first crop of fruits ripens and is removed, a circular trench about a foot deep and 6 inches broad should be made round each tree at a distance of about two feet from the trunk and the soil be mixed with two basketfuls of farmyard manure, one pound of oil cake and one pound of Nicifos II. Watering should be done after this manure application. This will ensure good fruiting in the second season. Papaya tree bears good crop for only three seasons. I have seen in the Pan gardens trees growing tall and lasting for 8 to 10 years. But fruit bearing is very much reduced, fruits will be small in size, kernel inside will be less, and not of satisfactory taste. Hence, it is always advisible to plant new plants. In order to keep the plantation going and secure regular crops two methods are adopted. Each has its own merits and may be adopted according to individual choice. The first method consists in dividing the plantation into four sections, planting one section every year. After the first lot of trees has fruited for three seasons, the trees should be cut down, the pits re-dug and manured and fresh plants planted. The following year, the second lot should be similarly dealt with, and so on each year. In this way after three years there will always be three lots of trees fruiting and the crop will not be very large from year to year. Second method consists in inter planting fresh plants in between two plants (i e; 5 ft. from the existing plants) when the fruit bearing plants are running their third year of fruiting. When the plants begin to fruit, the old trees having fruited for three years, should be dug out. This will ensure continuity of fruit bearing.

In this way, fruits will be available in the same field for at least six years. If the plants are planted in the same place after every three years, fruits can be had from the same field for a period of 12 years. After this, Papaya cultivation should be discontinued in that field for a period of at least three years.

Ripening.

Fruits begin to ripen in about fifteen months after planting. Most of the fruits ripen during the months of February to June. There are, however, some varieties which ripen fruits from September to November; and if some of these as well as of the later varieties are grown, the period during which ripe fruits can be obtained will be considerably extended.

The fruits ripen best when allowed to remain on the trees until one end - the apex - begins to turn yellow. They should not be allowed to fall on the ground. After removing the fruits from the tree, they are placed on a layer of dry straw on a shel or other convenient place in a room or shed and covered with dry straw. This process of ripening develops the full flavour of the fruits. Special care should be taken in handling the fruits, as they very easily bruise. Arrangements should be made so that all the fruits kept for ripening are arranged in single layers without touching each other. On no account should fruits be placed on top of one another, as the lower fruits are liable to be bruised simply by the weight of fruits above them.

Protection of Ripe Fruits.

Fruits allowed to remain on trees later than necessary are apt to be damaged by crows, birds, and bats. Protective measures against this damage as well as by sunburn, are cheaply done by tying round the fruits a piece of sack cloth or straw matting.

Best protection against climbing animals which do damage, is to tie a bunch of thorns round the stem of the tree just below the fruits.

Out-Turn.

As already pointed out under "Laying out a Garden" there can be 410 trees per acre. Papaya is a prolific producer of fruits. Taking the out-turn of each plant during one year at a minimum of 35 fruits, the total out-turn per acre works out to 14,350 fruits of an average weight of at least one seer each.

Packing Fruits

The ideal stage at which the fruits should be plucked for packing is when they have begun to turn yellow at the apex. Green and hard fruits plucked earlier than this, lose much of their flavour and those plucked later than this stage will be bruised in transit. The method of packing peaches advocated by M. A. Howard will be found satisfactory for fairly ripe papayas. The box in which the fruits are to be packed, should be divided into separate fixed compartments, one for each fruit, so that, in whatever position the box may be placed during transit the weight of no fruit will rest on another. All the fruits should be of nearly the same size and shape and should fit comfortably into the compartments. Packing should be done early in the morning when the fruits are cool. Each fruit should be thoroughly dry, and should be wrapped in thin paper over which some soft packing material such as sann or linseed fibre waste, should be wrapped. Each fruit should then be placed in a compartment and more packing material preferably Kodon straw or in its absence paddy straw should be placed between the fruit and the sides of the compartment, and also on top of each fruit, so that they can move in any direction. Best packing material wherever available is paper cuttings from a printing press or book binder's shop. Care must be taken to handle the fruits very gently through out the process, to aviod bruising. Fruits packed in this manner will be transported quite satisfactorily for fairly long distances, keeping quite fit and in good condition for a period of about a week from the time of plucking the fruits.

Varieties

There are several named varieties which are grown in various parts of India. They can be classified into two classes:—(1) Oblong or long shaped fruits, (ii) Round or melon shaped fruits. The former are better than the latter and seeds of this variety give more number of fruits. The following are some of the good varieties:—Honeydew, Washington, Madhubindu, Ceylon, Ranchi, and Bangalore.

Seed Selection and Its Preservation

Selection of seed and its preservation are important factors on which will depend the success of crops, specially in respect of papaya crop, since it produces three kinds of flowers as explained in detail under the head "Sex Problem". If good seed is not selected and preserved properly, the result will be very discouraging though all other factors stand satisfied. Fruits that are sweet, big sized, and have a good flavour, should be selected and allowed to ripen well, on the tree. Seeds should be removed from such well ripened fruits. Seeds from only the upper half of the fruit i. e., half from the stalk side should be selected, since majority of these seeds will turn out to be fruit, bearing trees, while greater percentage of seeds from the bottom half will turn out to be unproductive male trees. As a rule, choose a good fully ripe fruit which is full of kernel and in which the hollow seed cup is very small containing very few seeds. After removing the seeds, they should be washed so that the mucilage etc. attaching the seeds may be removed by rubbing. Then, a little ash should be mixed and seeds thus treated should be dried in shade and not in open sunshine. They should be lightly rubbbed over from time to time, so that they will dry evenly, when the seeds are quite dry, they should be preserved in tightly corked dark-coloured bottles till they are required for sowing.

(*To be continued*)

Inflammation

By

(S. K. Dighe, G. B. V. C.)

Inflammation is very common in all surgical conditions and a traumatic lesions, or it may be due to the following causes :—

(1) Mechanical inflammation due to blow and sprain, (2) Physical inflammation due to excessive cold or heat, (3) Chemical inflammation due to caustics, (4) Bacterial inflammation due to micro-organisms.

Inflammation due to micro-organisms is always more serious than that due to other causes, owing to the destructive local and serious general effects of toxins of many varieties of bacteria.

Symptoms : — The symptoms of inflammation comprise (1) Abnormal heat, (2) Swelling, (3) Redness, (4) Pain.

. The abnormal heat can be recognised by palpation, comparing the temperature of the inflamed part with that of the corresponding place on the other side of the body.

Swelling:—Will always depend on the nature of the inflammation. It will be more in vascular and in loose areolar tissues than in non-vascular structure and hard tissues.

Redness:—Is only seen in the non-pigmented skin.

Pain:—Depends on the acuteness of the inflammation, the nerve supply of the part, and the tension and heardness of the overlying tissues. The inflammation may cause functional disturbance in the organs which it affects.

If the cause of the inflammation be slight irritation, frequently repeated, it will turn into sub-acute or chronic state in which the above mentioned four principal symptoms will not be observed so distinctly as in the case of acute case. In sub-acute or chronic form of inflammation, comparatively large amount of fibrous tissue is formed, and afterwards a hard swelling will cause a permanent thickening of the part.

Terminations of inflammation will be :—

1. Delitescence in which condition the inflammation suddenly subsides as it is a very slight one.

2. *Resolution*:—In this termination the inflammatory exudate becomes reabsorbed, the damaged tissue is repaired by the formation of new tissue and the affected part presumes its normal condition although histologically it is not quite the same as it was before the injury was received.

3. *Suppuration*:—In this case pyogenic organisms have been the cause of the condition causing an abscess or other form of suppuration.

4. *Gangrene*:—This is considered as a termination of the inflammation, in which the damage of tissues is so severe that dead tissues of the affected part will never heal unless the part is amputated from the healthy portion.

5. *Induration* or thickenning of the part will result as the termination of chronic inflammation.

Treatment of acute inflammation :—

Removal of the cause:—The real treatment of inflammation is to suppress itsl cause or to remove its cause and after removing the cause; the following forms of treatment are useful.

1. Cold applications may be in the forms of cold compresses, which should be frequently renewed, cold water irrigations, cold baths or ice or snow applied to the part.

This treatment is only useful for slight inflammatory conditions in which the tissues are not dead, and when cold applications are used, it will contract the blood vessels, thereby diminishing the blood supply to the region and reducing the exudation.. Cold requires to be applied continuously for hours to produce its good effects.

2. Warm applications are indicated in severe inflammatory affections in which the tissues are seriously injured and are likely to undergo gangrene. Warm applications promote circulation in the damaged region, restoring blood supply in parts where it has been almost arrested and thus it will prevent the death of the affected tissues. They also soften the inflamed structures, thus releasing tension and relieving pain. Hot applications may be objected to on the ground that they favour the growth of micro-organisms in the parts exposed to infection, but this effect is counteracted by the hyperaemia and phyagocytosis which they produce. This applications may be in the form of, fomentations, compresses, poultices, or baths at the temperature of 104 to 122° F (30° to 40°c).

Medicated poultices are better than ordinary poultices made with linseed meal or bran. Antiphlogistine and similar preparations have an excellent effect when used in the form of a thick hot paste covered by a layer of cotton wool.

3. *Anodyne* preparations are to be used in very painful superficial lesions, such as opium or belladona mixed with glycerine or cocainised vaseline or iodoform ointment prepared with vaseline.

4. *Scarification* of the inflamed tissues may be performed to relieve tension and pain, but it is objectionable as it opens the way for infection, and may cause serious consequences, if careful antiseptic precautions are not taken.

5. *Antiseptic* applications are required for septic inflammatory lesions. For the foot and lower part of the limb there is nothing better than the warm antiseptic baths, continued for at least half an hour, 2 or 3 times a day, and during intervals, warm antiseptic compresses should be used.

6. *Massage and compression*:—These are very effective for inflammation in subcutaneous and deep seated tissues, including muscles, tendons and joints. Massage is effected by gradually increasing pressure of friction with the fingers over the affected part of the direction of the venous-current. It breaks down blood clots and distributes the inflammatory exudate over wider area, whereby it is acted upon by more absorbants and is more quickly removed. Compression is produced by an even layer of cotton-wool covered by a bandage sufficiently tight to create moderate pressure without having an uncomfortable effect. It promotes absorption by supporting the circulation.

Treatmeut of sub-acute aud chronic Inflammation.

These may be treated by moist heat, massage, compression and by counter irritation. Counter irritation may be effected by rubefacients, blisters and pustulants or by actual cautery, which is a blistering or caustic agent according to the way it is used.

Rubefacients—well known liniments are used as rubefacients, these, however, have a blistering effect when frequently applied and well rubbed in. Liniments are indicated for comparatively slight subacute inflammation.

Blisters—are very effective agents for many chronic inflammtory conditions such as biniodide of mercury, 1 part to 8 parts of lard, or Cantharides. 1 part to 6 parts of lard or a mixture of equal parts of these. Biniodide of mercury is largely used, as it has a very excellent effect especially in helping the absorption of the inflammatory swellings, including exostoses.

How to apply a blister !

Before applying a blister the hair should be clipped and the skin brushed. The blister should be vigorously rubbed in with the fingers for about ten to twenty minutes, taking care not to allow any of the preparation to come in contact with the hollow of the heel when being applied on the back of the limb, as it will cause cracking of the skin there, followed by inflammation and lameness. After blistering, the animal must be prevented from scratching or rubbing the part, which he is inclined to do owing to the irritation of the blister. For this purpose the animal may be tied up short in the stable or shed, or a 'craddle' a 'side stick' may be applied. A sack of hay between the fore-limbs in contact with the breast and suspended from the neck and back prevents the animal rubbing one fore-leg with the other. If one application of a blister has not had the desired effect, it may be repeated after the acute inflammation caused by the previous one has subsided. Avoid applying a blister in the angles of flexion of the limbs and in the axilla or the part between the humerus and the chest wall which correspond to the armpit in the human being, and grion, where it may cause fissuring of the skin, which is difficult to heal.

Pustulants are represented best by setons. A seton is a tape covered with an irritant medicine and passed beneath the skin over the affected part and left in the same place for some days. This will cause a purnlent inflammation in its track having a counter irritant effect on the deeper tissues. This is not much in practice nowadys, although it may be very useful for an old standing chronic inflammatory condition.

The actual cautery is the most powerful counter irritant for chronic inflammation and it will be dealt with saperately later on.

Specific inflammations caused by bacillus of anthrax and other specific micro-organisms are dealt with in contagious diseases.

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College and Hostel Notes

Examination Results: 1943

The results of the University and College Examinations were satisfactory this year, except the Intermediate in Science (Agriculture) at which our College did not fare well. Messrs. D. N. Kherdekar and P. S. Parsai were placed in the First Division at the B.Sc. (Agriculture) Examination. Mr. D. N. Kherdekar stood first in order of merit, for which he was awarded the Sir Arthur Blannerhasset Memorial Gold Medal, and the Chakradeo Memorial Medal. Mr. N. P. Sinnerkar who stood first at the Intermediate in Science (Agriculture) Examination was awarded the Sir Arthur Memorial Gold Medal. Messrs. B. N. Kanungo and M. M. Mundle stood in the first division. We congratulate the above students for their distinguished success.

Opening of the Session

The College opened on the 21st June. The rush to the first year class, this year, was great as usual.

College Elections

The following office-bearers are elected for this session.

1 General Secretary:—N. G. Hande, III year.
2 Sports Secretary:—M. L. Purohit, III year.
3 Football Captain—C. S. Iyer, III year.
4 Hockey Captain—A. Q. Khan, III year.
5 Volley-Ball Captain—R. N. Khandelwal, IV year.
6 Hu-tu-tu Captain—V. P, Chiddarwar, IV year.
7 Tennis Secretary—C. C. S. Mudliar, IV year.
8 Self-help and Debating Society, Secretary—N. P. Sinnerkar, III year.
9 „ Joint Secretary—A. M. Diwekar, II year.

NOMINATIONS

Librarian—B. N. Kanungo, III year.
Association of the Quiet Hour—
Secretary:—P. S. Malviya, III year.
Joint Secretary—G. A. Gangrade, II year.

We congratulate the above office-bearers and trust that they will discharge their duties most enthusiastically.

Sports

Practice has now begun in Hockey, Football and Volley-Ball. It has been decided, this year, to hold the Gokhale Memorial Inter-Collegiate Volley-Ball Tournament.

Hostel

The hostel is almost fully occupied. The inmates are well looked after owing to the keen interest shown by our wardens Messrs. S. K. Mishra and K. S. S. Iyer.

The Nagpur Agriculture College Magazine

COLLEGE OF AGRICULTURE, NAGPUR, C. P.

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1942-43

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N. B.— The Editor does not hold himself responsible for the opinions expressed by contributors.

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The Nagpur
Agriculture College Magazine

Vol. XVIII | August & November | No. 1 & 2.

Editorial

J. C. MacDougall, Esq., M. A.; B.Sc.; I. A. S.; C. I. E., who was for the past several years the Director of Agriculture, C. P. & Berar has gone on leave preparatory to retirement. His services to the various sections of the Agricultural Department in the province where he has worked in various capacities have proved extremely valuable. With keen interest in the welfare of the agricultural classes, he applied himself with indefatigable industry and fruitful resource in serving them in as many ways as possible. During his tenure of office as Director, he initiated and worked out various schemes calculated to improve the agricultural technique and marketing practices, the good results of which are by now apparent. He was at the helm of the affairs of the Department at the most critical moment when he was called upon to initiate and push on the food-drive owing to the exigencies arising out of the War. The success of " The Grow More Food" Campaign bears an eloquent testimony to his ceaseless efforts.

We learn that after a comfortable voyage he has reached safely his native place in Scotland. We wish him a well earned rest after such strenous duties, and a lappy long life.

We offer heartiest felicitations to R. H. Hill, Esq., M. A.; I.A.S., on his appointment as the Director. As Deputy Director, Economics and Marketing he is too well-known for his contribution to the development and reform of agricultural marketing. Shortly on his assumption of the new office he organised the Agricultural Section of the War Services Exhibition at Nagpur. The idea of including this Section in the Exhibition was indeed novel. The Economic holdings, occular demonstrations and the scores of charts and slogans exhibited therein have served immensely in bringing home to the cultivators the results of scientific investigations and their application in the growth and development of agricultural produce. The task of pushing forward the "Grow More Food" Campaign has now fallen on his shoulders. This task is now of prime importance as is evidenced by the famine conditions in the country. We wish him every success in the arduous work before him.

Grow More Food

Wake-up farmers! come to the field,
Grow more crops, and get more yield;
Clouds of ill-luck, all are gone,
Fortune's ray is shining yon,
        Earn with peace your livelihood,
        Grow, grow, grow more food.

(2)

Plough-up new and fallow land,
Make fertile the barren sand;
Dig away all the wild weeds,
Sow the fields with healthy seeds.
        Lower the mountains, cut waste wood,
        Grow, grow, grow more food.

(3)

Grow but a small cotton crop,
Vegetables should be on top;
Grow juar and rice and wheat,
Prosperity is at your feet.
        Make your life both happy and good,
        Grow, grow, grow more food.

(4)

The rich have not enough to eat,
The poor are dying in the street!
Children starve before parents' eyes,
Struggling with Death midst tears and cries!
        Come to their help with fortitude,
        Grow, grow, grow more food.

(5)

Your brothers brave still fight afar,
And will fight on, till they win the war,
Maintain the strength of their splendid arms,
With the rich bounty of your farms.
        Foster the bonds of brother-hood,
        Grow, grow, grow more food.

(6)

Awake! arise to the nation's call,
Your plough shall hasten the foemen's fall;
Work with a will, and work with your heart,
Victory is yonder, play your part.
        Toil and toil for the country's good,
        Grow, grow, grow more food.

—**M. P. Shrivastav,**
IV Year.

Physical research on Problems of Soil Cultivation.

By

B. A. Keen, M.A., D.SC., F.R.S.

Editorial:—

[The latter part of Dr. Keen's article, on "Physical research on problems of soil cultivation" contributed to the April 1942 issue of the Endeavour relating to research work on soil–water and its practical implications, is reproduced here.

In the first part of his article Dr. Keen has given a historical review of the work on physical researches on soils, beginning with the work of Schuber in Germany and followed by the work of the eminent scientists. Sir Humphery Davy, Lawes, Gilbert. Higard. King, Warington. The discussion on the construction of mouldboard ploughs is very absorbing.

"Dr. Keen's article challenges many traditional ideas about agricultural methods. In particular, he brings evidence to show that, contrary to deeply ingrained tradition, crop yields are remarkably insensitive to variations in cultivation; and that the attractive 'capillary tube' theory of the movement of soil moisture is entirely untenable".

Introduction of mouldboard ploughs marked the first era of agricultural development in India This new line of thought may have far reaching effect in modifying this policy; and ploughing may become restricted only to a few acres of land brought under plough for the first time or very weedy fields. It is widely known that 'black cotton soil ploughs itself'. The profile which is characterised by absence of any definite horizons shows the complete admixture of the surface and subsoil to a considerable depth as a result of deep cracking in summer. It is questionable whether ploughing is still necessary for such soils. Very little experimental evidence is available to justify the economic and scientific aspect of ploughing of land in India. It will be valuable to examine the problem of cultural practices in the light of this new theory.]

" Generalizations have grown up in soil physics, often based on simple experimental procedure, the results of which seemed to give a qualitative but plausible grouping of various soils into classes. The need for some such specification was as evident then as now, but it resulted in the appearance of many soil 'constants' and 'equilibrium points': most were empirical, some were spurious, others contained not one, but a complex of factors, and yet others depended on the subjective judgment of the experimenter. Part of the task of the modern soil physicist is to explore this collection and to reject, amend, or replace.

The so-called soil constants and equilibrium points fall into one or other of. two classes. In one class, the soil and water are kneaded into a paste, and some property is measured on the sample: it may be the force for rupture of the dry block, the volume of shrinkage of the block on drying, the lowest moisture content at which the sample can be rolled out without cracking the moisture content at which it is just becoming sticky, or the moisture content at which the paste begins to flow when tilted. Measurements of this kind were developed and extensively used by ATTERBERG in Sweden in a system of soil classification, and they are of the kind that would naturally be used by agricultural engineers interested in the behaviour of soil towards cultivation implements of various types and designs.

In the second class the soil is used in its natural loose field condition (or in an analogous state of packing) when its pore space will be about 25 to 50 percent., depending on the type of soil. This class of measurement attempts to specify the behaviour of the soil in natural conditions by a series of moisture contents corresponding to a series of prescribed environmental conditions. It is unnecessary to mention in detail the many measurements proposed and used. Some had their origin in attempts to make an agricultural classification of soil types; others were devised in efforts to give some numerical specification of practical observations on soil conditions in relation to plant growth and the effects of cultivation operations.

During the period 1900–25 the development of these soil 'constants', and the discovery of simple relationships between them had a fascination for many soil investigators. It was, however, a dangerous occupation, especially for those who did not realize that the ease of making a particular measurement, and the straight forward reproducibility of the numerical result, were no guarantee that the figure expressed any real and simple physical property of the soil. Again, the existence of simple cross–relationships between two or more so–called independent constants was no proof that these constants had a simple physical interpretation. The primary objection to the incautious development of these constants and cross–relations is that they inevitably lead to a classification scheme. Superficially this scheme is in accordance with the field behaviour of soil moisture, but as a foundation for the further development of a basic theory of soil-moisture relationships it is useless. Part of the trouble was that investigators took over from their predecessors without serious question the early theory of soil-moisture movement, based on the 'capillary-tube' hypothesis. The theory was simple and attractive, and required no deep physical training for its understanding. Soil was porous, so the pore space could surely be regarded as a bundle of capillary tubes in which water would distribute itself in accordance with the simple concepts of surface tension and capillarity. It was admitted that the tubes must be irregular in cross-section, but it was convenient to assume that that could produce only minor discrepancies.

The essential feature of the phenomenon of capillarity is that the narrower the tube the greater is the height to which water will rise in it. At one stroke, therefore, the observed difference between drought-prone, coarse-grained, or sandy soils and drought-resisting, fine-grained, or clayey ones was explained. In the latter the capillary tubes were much narrower; they could draw up water from the underground water-table through much greater distances than sandy soils could. The traditional belief that hoeing conserved soil moisture had an equally facile explanation: hoeing disrupted the upper inch of the fine capillary tubes and produced a loose mulch with large pore spaces into which the water could not rise and be lost by evaporation. The agricultural operation of rolling young crops had also a simple explanation: the roll compressed the top soil round the young roots so that the narrower capillary tubes thus produced could draw water from the wider ones below for the benefit of the plant. It only remained for some numerical value to be put on the maximum effective height of capillary rise in typical soils and the practical demonstration of the theory would be complete. Laboratory and field experiments, however, showed rises of only 2 to 3 ft., instead of the confident predictions of 10 ft., 30ft., or more, yet the theory still bore a charmed life.

The first hint that all was not well with it can be found in a paper, *The Dynamics of Soil Moisture*, written by Briggs in America as long ago as 1897. But he omitted an apparently unimportant step in developing his argument–a step which over thirty years later was recognized by Haines at Rothamsted as the key to the problem. In 1917 Versluys in Holland reopened the subject on lines which were correct although obscurely expressed. Later, at Rothamsted, Haines, and then Schofield worked out the correct theory of moisture movement in soil and confirmed it experimentally. Haines showed that the spore space in soil was essentially of a cellular nature, consisting of relatively large voids communicating with one another through relatively narrow necks. The moisture distributes itself in curved films within these cells and necks in accordance with physical principle that it tends to reduce its free surface, and hence its surface energy, to a minimum. The pressure under a curved water meniscus is less than outside, and the greater the curvature the greater is the pressure deficiency, therefore, is a suction force which controls the filling or empting of the cells.

The manner in which filling or emptying occurs can be seen by taking a simple case. Let a cell and its necks be full of water and suppose evaporation is taking place at one of the necks. The water level in this neck will retreat steadily, until the meniscus reaches the narrowest cross-section of the neck. Here the equilibrium becomes unstable, because further retreat of the meniscus carries it into a wider cross-section where a smaller pressure deficiency than the one already built up would be adequate to maintain equilibrium. Hence expansion into the cell takes place abruptly, or, in other words, air suddenly enters the cell and a portion of the water is displaced to new positions.

Similarly, when the moisture content is increasing from dryness to saturation, once the thickness and curvature of the water film lining the cell and necks attain a certain value, instability sets in. The films in one or more of the necks suddenly close; the stability of the air bubble in the cell is upset and the cell becomes full of water. One salient feature of the moisture relations is, therefore, the quantum–like movements of water associated with filling and evacuation of the cells. But there is another important consequence of the theory; the opening and the collapse of a neck (and the emptying and filling of a cell) do not occur at the same pressure deficiency and moisture content. The relationship between them shows a marked hysteresis loop. Hence regions of high and low moisture content can exist in equilibrium together. Haines demonstrated the truth of this by simple and ingenious experiments. The hysteresis loops obtained for a mass of minute glass sphere and for sand showed that the drying curve lies wholly above the wetting curve. Hence the moisture content in eqilibrium with a given pressure deficiency is higher if the soil is drying out than if it is being wetted. Again, by suitable cycles of drying and wetting the moisture content can be brought to any value within the hysteresis loop.

Haines' treatment of the problem is specially applicable to coarse, sandy soils. Schofield's later contributions produced a generalized physical theory based on energy relationships. Because it deals with energy relationships, this treatment has a great advantage: it is applicable to all soils and holds whatever the mechanism at work. Schofield expresses the differences in suction forces as free energy differences, which can be defined as the height in centimetres of the water column needed to give the suction in question. A logarithmic scale is used because of the wide range of this factor. Thus when the moist soil is in equilibrium with an atmosphere of 50 per cent relative humidity ('air-dry' soil) the equivalent water column would be about 10 km. high, or higher than Mount Everest. By wetting and drying soils against suction and by using results for soil vapour pressures and freezing point depressions at different moisture contents, Schofield was able to obtain curves which showed the hysteresis loop strikingly.

An important practical consequence of the hysteresis is that the water in the soil tends to resist changes, whether these are in the direction of increasing or decreasing moisture content. Instead of moving through the pores from regions of high moisture content to low, it will adapt itself to the suction gradient mainly by an alteration in the configurations and curvatures of the water films. To use an expressive Americanism, the water 'stays put' if it can. The bearing of this on the question of water supply to plant roots is obvious. The capillary theory taught that the drying due to water-imbibition by the roots was met by movement of water from the moisture regions *i.e.* the water brought to the plant roots. The correct view, however, is just the opposite: the plant roots have to ramify extensively through the soil in search of moisture. We can now see in their true light the real effects of hoeing and rolling. The action of rolling is primarily the purely mechanical one of compressing loose but moist soil more closely around the roots of the young plant, so that they can more easily obtain the moisture. For any water movement of the type postulated in the capillary theory to take place, the soil would have to be so moist that no farmer would think of ordering the operation; the results on soil tilth would almost certainly be disastrous.

As for heoing, there can be no general upward movement of water except in those cases of low-lying land where a water-table is very near the surface, and even then the rate of upward movement is exceedingly slow. In this case as in the much commoner one where the water-table is well below the surface, the tendency of the water to resist changing conditions means, in effect, that it evaporates *in situ*; the dried-out surface layer progressively deepens. Most soils are, in fact, 'self-mulching' and the use of a hoe, to produce a soil mulch is from the viewpoint of direct water conservation, a work of supererogation, except for those soils that end to produce a hard crust or cap when drying. In these cases hoeing will break the crust in its incipient stages and so save the tender roots from damage. Of course, by destroying seedling weeds, hoeing prevents their competition for the available moisture and thus, indirectly, the operation conserves water.

The correct idea of soil moisture relation-ships, outlined above, enables us to form a clear picture of what happens to the rain when it has reached the soil. The soil is, normally, in the condition known as crumbs or compound particles, especially of the finest ones—the so-called clay fraction-which display this property of aggregation to a marked degree. The crumb itself is permeated by minute pores, much smaller then the pore spaces between the crumbs. If the soil is fairly dry and rain then falls, it enters the minute pores of the crumbs in the top layer. The excess rain passes downwards through the larger and cell-like pores between the crumbs and, in turn, each layer of crumbs levies toll on it. Depending on its amount and on the initial moisture content of the soil, the fate of the rain will fall between two extremes: it may be held wholly in the upper layers of soil-a frequent occurrence for summer showers-or it may displace water already in the soil, which percolates downwards until it reaches the water table-a condition which is common in winter, when the pore spaces are practically saturated. Each soil crumb can be regarded as a minute water reservoir which, with any water left behind as a film in the bigger pores between the crumbs, is actively sought out by the exploratory root hairs on the plant's ramifying root system, which traverses its zone of growth so completely that the root hairs are never far away from a supply of moisture. This root system ranges much deeper than is generally thought, because few subsoils are so tight as to offer a complete barrier to the passage of roots and moisture. Studies of root behaviour made in America, and to a lesser extent elsewhere, show that the roots of common agricultural crops reach a depth of several feet: wheat, oats and sugar-beet, 5 to 6 ft; barley, 3 to 4 ft; and potatoes, 3 ft.

Modern science has shown, therefore, that cultivation operations have only a minor influence on the moisture regime of the soil and in consequence, much of the traditional belief on this subject must be abandoned or recast. When these traditions are examined closely it is seen that although they embrace the three factors, cultivation, moisture, and plant growth many are short-circuited into a direct relation between cultivation and plant growth. The gardeners' exhortation to 'keep the hoe moving among the crops' is a familiar example, and it is no exaggeration to say that most farmers believe that their crops will suffer by just the amount that their cultivation was well established long before agricultural science developed, and the practical man naturally felt that the operations were so obviously fundamental as to lie right outside any need for experiment. In settled countries innumerable field experiments have been made on artifical fertilizers and the number of such tests is still increasing, but experiments on cultivation were hardly ever made; yet the costs of cultivations are the heaviest single item in the arable farmers budget and for exceed those for artifical manuring. In countries where agricultural development came later, experiments on cultivation were made, notably an extensive series in the Great Plains region of America, but the results were ignored in this country for the apparently adequate reason that as they were done in an area of low rainfall, the conclusions could not possibly apply to our conditions.

Such was the position some dozen years ago, when cultivation experiments were begun at Rothamsted. Slowly but surely all the more surely because it was against their preconceived ideas—the investigators were driven to the conclusion that crop yields were remarkably insensitive to variations in cultivation. All the experiments were full-scale trials: none can be dismissed on the grounds that it would not apply to practical field conditions. A variety of cultivation procedures was tested on different crops and in different seasons, and the work is still going on. The main results are briefly summarized in the next paragraph.

Subsoiling is a standby of many heavy-land farmers, but on the Rothamsted soil, which has a heavy clay subsoil, the operation produced no effect on sugar-beet. The normal preparation for root crops includes both autumn and spring ploughing, and if bad weather prevents the autumn ploughing some apprehension is felt as to the quality of the spring seed-bed; tests made with potatoes and sugar-beet as the crop showed that the double ploughing gave only an insignificant increase of yield over a single ploughing and not nearly enough to pay for the cost of the extra work. Deep ploughing every year was no more effective than shallow ploughing, but there was slight evidence that an occasional deep ploughing gave a little increase in the yield of root crops. The nature of the seed-bed itself was also studied and it was found that it has little influence on the final yield. Many experiments have been done on the inter-row cultivation of root crops, in which the minimum hoeings necessary to keep down the worst of the weeds have been compared with a greater number of hoeings. For a number of years the result of the extra hoeing was either no increase in the crop or, more often, a significant reduction in yield, a result due in all probability to the inevitable damage done to shallow-feeding roots. In some of the later experiments on inter-row tillage an increased yield was sometimes obtained. The design of the experiments enabled this positive effect to be traced to one hoeing done in the early stage of plant growth, and the effect has been confirmed in experiments on another type of soil. It suggests that farm and garden crops are specially sensitive to weed competition in the early stages of their growth and that one hoeing then is worth many afterwards.

The net results of all this work is to show that provided the crop has a reasonably fair seed-bed, that it is given a hoeing in its early stages, and that the worst of the later weeds are kept down, then any cultivation of the soil–whether before sowing or during growth–in excess of this minimum is of little direct value to the plant. The results are in harmony with those reached by the investigators on the Great Plains area, and they are in harmony with modern knowledge of soil physics. They are in conflict with a deeply ingrained tradition, which had at least three apparently sound reasons behind it, as well as the capillary theory. The first of these reasons was that until the Industrial Revolution provided the farmer with good implements he fought a losing battle against weeds: cultivation at every available opportunity was his only hope. The second reason was that cultivation in the early stage of plant growth sometimes produces striking results, and it was assumed that the yield would benefit correspondingly; the Rothamsted experiments have occasionally shown similar effects which have, however, disappeared by harvest time, so that the ultimate criterion–yield–has not been affected. The third reason was that keen and successful farmers were, almosts invariably, enthusiastic exponents of the art of cultivation. This was perhaps the most cogent argument of all to the average farmer: surely these leaders' farms and bank balances proved that their views were correct. But the real reason for their success lay not in the artistry of their cultivations, but in another quality, for which a traditional reason also exists: ' the master's footsteps are the best manure for his land.'

If the present article had been written twenty-five years ago, when the vast majority of cultivation implement was horse–drawn the results of the cultivation studies now discussed would have had little more than academic interest. A horse costs nearly the same to keep whether he is working or idle, so the real cost of cultivation was negligible. But now, few farms are without a tractor, and the bulk of all cultivations is done with power–drawn implements. A tractor, properly looked after, does not cost anything when idle, and the more it works higher is the fuel and oil bill. There is, therefore, a powerful economic reason to reinforce the scientific arguments for a complete and critical examination, on all types of soil, of our cultivation methods. "

* * *

The Cultivation and Marketing of Papaya.

By

R. A. Ramaya Esq., L. Ag.

(Cantinued from the previous issue)

Insect Pests and common diseases:—Regarding insect pests Mr. T. B. Fletcher writes as follows:—"so far as insect pests are concerned, there are practically none that are of any importance to papaya in India. The lava of a small tineid moth (*Hapsifera rugosella, Stainton*) is often found burrowing in the outer bark of older trees. The papaya fruit is apparently very well protected by its milky juice against attacks of all insect pests."

Regarding common diseases Mr. A. K. Mittra writes as follows:- "The most important diseases of papaya may be classified under two heads:—

(i) The stem-rot of papayas.
(ii) The leaf-curl of papayas.

Both these types of maladies are pretty commonly met with wherever papaya is grown, and it is essential that the papaya growers are able to recognise and control them at their earliest inception from certain external symptoms, which are described below:—

(i) *The 'stem-rot' of papayas.* This disease is capable of considerable damage. It is at its height during a warm, humid season, such as during the monsoons.

The stem is affected generally near the ground level, but the disease may occur at higher points usually not above 5 feet from the ground. The affected areas of the stem, show at the beginning, a characteristic water-soaked appearance and are soft to touch. The bark at such places is easily peeled off, exposing the inner tissues of the stem often in a semi-rotten state. A keen observer will be able to observe these early symptoms. After the disease has progressed for sometime, the rot openly expresses itself. A liquid, ooze, foul smelling, may often be seen flowing out through cracks in the bark. The bark itself may be shed off from such affected areas. The rot once started, progresses with alarming rapidity during a damp season advancing in a downward or an upward direction, or may girdle round the stem at particular regions.

The causal organism of this disease has been shown by Mr. Subramaniam to be a species of '*Pythium.*' This fungus is a soil dweller. One of the species of this fungus is also largely responsible for the "Damping off" of seedlings in nurseries.

As control measures, the following have been found to be useful. Attention should be directed to the proper drainage of the soil. This is of primary importance. During damp seasons a good watch should be kept on each plant and any diseased patches noticed on the stem should be forthwith dissected so as to remove all traces of the affected tissues containing the parasite. The healthy inner tissues thus exposed on such dissected areas, would be washed with some antiseptic solution, e.g., 4 to 5 per cent Lysol, and finally dressed over with a coating of some preservative substance. Coal tar is very handy for this purpose. According to Mr. Subramaniam "Sanitary-fluid or crude carbolic acid mixed with an equal quality of water when applied with a brush has been found to be very successful."

(ii) *The 'Leaf-curl' of Papayas*:—This disease although not so common as stem-rot, is probably more serious in its effect on the plant. The main symptom is the curling of the leaves, generally the top-most ones, and in most cases the main apical bud is thus affected. The top leaves are thus deformed, with their stalks becoming twisted and wavy. They remain small in size and hardly ever grow or spread out, giving an impression of a bunchy 'top.' The growth of the entire plant is arrested and it consequently remains dwarfed.

The attack is more common on young seedlings than on older plants. When older plants are attacked, the plants fail to hold on their fruits, which are generally shed off while yet quite small. A few fruits may grow into worthless products.

The attacked plants, especially the young seedlings, seldom recover from the disease. They do not generaly die, but just live on as dwarfed, unsightly leprotic specimens. The curled and crinkled leaves have a very uneven surface consisting of elevations and depressions, giving an impression of the type of surface possessed by the leaves of the Savoy Cabbage, and hence such leaves can typically be described as "savoyed".

While nothing definite is so far known or discovered about the real nature of the disease, it is more or less certain that the disease is favoured in damp, shady situations, coupled with unfavourable sub-soil conditions.

In view of the above and the fact that the affected plants seldom recover, the best and most economical course for control lies in rooting out the diseased plants and destroying them, preferably by burning. Fresh planting should be done on a better drained plot in more open situations.

Medicinal Properties.

Papaya has many good properties. Every part of the plant is medicinally useful. Its roots and fruits are used in preparing invigorative medicines. Fruits are digestive, laxative, invigorative and very useful in spleen, piles, indigestion and Hœmoptisis. All stomach disorders are removed by eating papaya fruits. Ugly marks or scratches on the face are removed by rubbing for some time one or two pieces of the fruit, and the face will become beautiful. Vinegar of papaya fruits is an infalliable remedy for enlargement of spleen. The milky juice of the stem, leaves and and green fruit of the papaya has remarkable digestive effect. It is considered to be of great value in the treatment of dyspepsia, and similar diseases. The use of this milky juice cures eczema, intestinal worms, sores and boils. If people suffering from indigestion take every day after meals one or two grams of milky juice with candied sugar, (Battasa) they will find it to their relief within a few days. Two or three drops of milky juice added to the ripe fruit will be very useful for the disorders of spleen. Rheumatic pain diminishes in its severity by tying the leaves of papaya. The seeds are anthelmentic i. e., of use against intestinal worms. The seeds are used in quenching thirst.

Culinary Uses.

Papaya can be used both in its green or unripe, as well as in its ripe state. In its green or unripe state, the fruit is used as a vegetable and when cooked is very much like pumkin. It is used largely for pickles, chutnies, and is also sometimes used in curries. Addition of a piece or two of green papaya fruit, will cook the meat nicely, and make it quite tender. Meat wrapped in the leaves for a few hours is said to become quite tender.

Other Uses.

In foreign countries, ropes are prepared by extracting fibre form the bark of papaya tree.

Fruit and its products.

Ripe fruits are much esteemed, more especially during the early months of the hot weather, when other fruits are scarce. In its natural condition, it is an excellent fruit to be taken after dinner. Some people eat the ripe fruit with a little sugar and fresh lemon juice, and some others with pepper and salt. The fruits are delicious and contain vitamins A, B, and C. When in season, it is a favourite ingredient of fruit salads. Papaya fruit syrup is a good healthy drink. Jam and jelly are prepared from ripe fruits. Morabba, pickles, and chutney are also prepared. This in itself will be a subject matter of a separate article entitled "Papaya Fruit Products" which will be published separately.

The milky juice of the green fruit of the papaya contains an enzyme or ferment called "Papaya". Papain is an article of commerce and has taken the place of pepsin. This has a great demand in the medical world due to its medicinal properties.

Scope for increasing its cultivation.

Out put of papayas in India is very much less as compared with Ceylon and West Indies. Especially in the Central Provinces and Berar, it occupies a very minor area. It is an undisputable fact that papaya cultivation ensures good monetary return. Papain manufacture together with fruits will undoubtedly bring greater profits.

This is something in which all who grow papayas even on a small scale, can take part. Improvements are possible in the following directions:— (i) Selection of fruits from which seeds are saved aiming at excellence of flavour, heavy cropping and large size, (ii) Selecting plants with unusual earliness or lateness in ripening, for continuity of fruiting during all seasons. (iii) To develop fruits with thicker or harder skin, which would not bruise easily, would be a noteworthy achievement. (iv) To develop a type or strain of papaya, in which the male tree which bears no fruit, will have been eliminated and its place taken by the hermaphrodite tree which produces fruit as well as pollen.

The following experiments are being conducted on the Damoh Farm.

(i) Effect of planting plants at different times, viz. in July, September. November, and February on the period of fruiting.

(ii) Selecting best fruits for seed purposes, in order to improve the varieties.

(iii) Application of fertilisers in different doses and its effect on fruiting.

(iv) Application of potashic manure in the shape of ashes as potassium sulphate and its effect on papain content.

(v) Branching of papayas and its effect on fruiting.

(vi) To ascertain whether the plants turn out to be male or female or hermaphrodite by different experimental trials.

(vii) Treatment for 'leaf—curl' and 'stem-rot' diseases.

(viii) To ascertain the effect of horse dung as manure as compared to Farm yard manure.

(ix) To ascertain the maximum fruiting capacity and the ideal number of fruits that should be allowed to ripen in each season, by resorting to thinning.

(x) Experimental work on 'Papain'.

The following records of performance of different varieties during its first fruiting season, maintained on Damoh Farm will be of interest to the readers of this article:—

(A) VARIETAL PERFORMANCE.

Name of variety.	No. of plants fruited.	Total N. of fruits	Total, value Rs. As P.	Average No. of fruits per plant.	Average value fecthed per plant Rs. As. P.
1. Ceylon	3	140	12 11 0	47	4 3 9
2. Madhu Bindu	2	92	8 1 9	46	4 1 0
3. Bangalore	1	38	3 7 6	38	3 7 6
4. Ranchi	5	93	10 7 0	19	2 1 6
5. Washington	3	58	4 5 3	19	1 7 0
6. Honeydew	2	22	1 12 0	11	0 14 0
7. Local	4	36	2 7 3	9	0 9 9
Total	20	479	43 3 [illegible]	24	2 2 6

(B) INDIVIDUAL PERFORMANCE OF TREES.

Serial No.	Name of variety.	Date of planting.	Date of first fruiting (ripe)	Total No. of fruits	Total value Rs. as. p.	Average weight of each fruit.	Maximum weight of one fruit.	Remarks.
1.	Madhubindu	20-10-39	20- 9-40	28	1/12/6	1 sr.	3½ srs.	Early fruiting
2.	„	19-10-39	18-12-40	64	6/ 5/3	1½ srs.	2¾ „	Regular fruiting
3.	Honeydew	10- 8-38	17- 4-41	8	-/ 7/-	¾ „	1¼ „	Late variety.
4.	„	„	24- 2-41	14	1/ 5/-	1½ „	2¾ „	do

Serial No.	Name of variety.	Date of planting	Date of first fruiting (ripe)	Total No. of fruits	Total value Rs. as. p.	Average weight of each fruit.	Maximum weight of one fruit.	Remarks.
5.	Washington	,,	10- 2-41	26	1/14/-	1¼ ,,	1½ ,,	Medium variety.
6.	,,	,,	29- 3-41	15	1/ 6/6	1½ ,,	2¼ ,,	,,
7.	,,	,,	2- 3-41	17	1/ -/9	1 ,,	1¾ ,,	,,
8.	Ranchi	,,	8- 2-41	25	2/ 9/3	1⅔ ,,	3½ ,,	Good sized fruits.
9.	,,	,,	7- 2-41	22	1/14/-	1⅔ ,,	2 ,,	,,
10.	,,	,,	3- 4-41	15	1/ 9/9	1⅔ ,,	2 ,,	,,
11.	,,	,,	27- 2-41	17	3/ 7/3	3¼ ,,	4 ,,	,,
12.	,,	,,	10- 2-41	14	-/14/9	1 ,,	2 ,,	,,
13.	Ceylon	,,	10- 2-41	27	2/10/6	1⅔ ,,	3 ,,	Fruiting regular and extended till end of June.
14.	,,	,,	19- 2-41	28	2/13/6	1¾ ,,	2½ ,,	,,
15.	,,	,,	10- 2-41	85	7/ 3/-	1⅓ ,,	2¼ ,,	,,
16.	Bangalore	,,	8- 2-41	38	3/ 7/6	1½ ,,	2 ,,	,,
17.	Local	,,	27- 2-41	10	-/14/-	1⅖ ,,	1¾ ,,	,,
18.	,,	,,	10- 2-41	16	-/13/-	¾ ,,	1 ,,	,,
19.	,,	,,	13- 2-41	6	-/ 5/3	¾ ,,	1 ,,	,,
20.	,,	,,	5- 3-41	4	-/ 7/-	1¾ ,,	2¼ ,,	,,

CONCLUSION.

Papaya cultivation is very easily possible in every district and in every village. I have seen some villages wherein good fruiting was observed with practically no care and attention. If the cultivators and malguzars in towns and villages would only take into their head to start with a beginning of only one acre of its plantation, they will know for themselves how profitable is its cultivation. This can even be suggested for removing unemployment amongst the youths of the province. This aspect of the question needs due encouragement, such as giving preliminary facilities.

Cost of cultivation and net profit.

Cost of cultivation and net profit that would accrue from one acre of papaya cultivation is as detailed below :—

EXPENDITURE.

(*a*) *For three years.*	Rs. As. P.
1. Initial cultivation with green manuring of sann hemp.	5 / 15 /-
2. Digging charges of 400 pits 2x2x2 @ -/1/- per pit.	25 / 10 /-
3. Farm yard manure 100 cartloads @ -/4/- per cart.	25 / - /-
4. Bone manure fertiliser 410 lbs. @ -/1/- per pound.	25 / 10 /-
5. Sand 410 basketsful @ -/-/6 per basket.	12 / 13 /-
6. Purchase of garden tools, mhote and its requisites etc.	55 / - /-
Total Rs.	150 / — /-

EXPENDITURE.

(*b*) *Annual recurring.*	
1. Labour :— 1 Man @ Rs. 8/-/- p. m. 1 Boy @ Rs. 5/-/- p. m.	156/-/-
2. Feed for bullocks @ Rs. 10/-/- p. m. ...	120/-/-
3. Depreciation of bullocks and implements. ...	24/-/-
4. Rent of land	3/-/-
5. Extra manuring and fertiliser after every season @ -/3/- per plant. for 410 plants.	77/-/-
6. Miscellaneous.	20/-/-
Total Rs.	400/-/-

i. e., Rs. 50/- per year. (A)

Total annual expenditure Rs. 400/- plus Rs. 50/- = Rs. 450/-

INCOME EVERY YEAR.

From fruits, Rs. 2/- per tree for 410 trees = Rs. 820/-

Net profit per acre Rs. 370/- in one year.

If papain is manufactured by extraction of the milky juice from unripe fruits, there will be extra net income equal to the above figure of netprofit.

Note:— The figures of expenditure given above are on the basis that bullocks, bullock-cart and well together with necessary land are already possessed by the cultivator. The figures noted above may vary a little in different places, according to local conditions, but that variation will not be much.

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Vegetable & Food dehydration.

Prefesor John E. Nicholas of Pennsylvania State College has discovered that electric radiant energy of infra-red drying lamps can be used to speed dehydration of fruits and vegetables. The dehydration apparatus includes a structure to support infra-red lamps and drying begins immediately. No enclosure is needed since infra-red rays penetrate material and the water vapour escapes easily. Tests were conducted with apples, spinach, beets, carrots, potatoes and celery. (U. S. Office of War Information).

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Detecting dirty milk

Dirty methods of production and bad method of collection and distribution allow a large amount of bacteria to grow in the milk. Research workers at Aberystwyth and Reading have developed a test with a dye, known as the resazurin test. This test merely involves holding a little milk with the dye in a water bath at 37°C. for a fixed time (e.g. 1 hour) and then matching the colour in a comparing apparatus. Milk of good hygienic quality (a small amount of bacteria) remains blue, which dirty milk changes to purple, pink or colourless. The 'rapid resazurin list' which takes only ten minutes is the most reliable quick test for milk supplies arriving at the creamery. The test is obviously one of great potentiality.

(Monthly Science News Sept. 1942.)

" External Morphology of certain Lesser Millets "

By

B, B. Mishro, B. SC., (Agr.)

Introduction :—The morphological part is of prime importance in the systematic study of any crop plant. The anatomical studies and the observation of the anthesis of the flowers reveal their mechanism and tendency towards the type of pollination that would be of common occurrence in a particular species. If the flowers are self-pollinated, the improvement that would be brought about by either ordinary mass selection or pedigree culture might possibly have less chance to revert back to their original state because the chances of cross-pollination and the consequent bringing of the heterozygous characters into conflict can be completely eliminated. On the other hand, if the the flowers are cross-pollinated then the plant-breeder would have to be very cautious and should take every possible step to see that the selected and improved species do not deteriorate. The knowledge of the number of stamens, the mode of insertion of the anthers, the situation of the pollen grains in the anther and the nature of stigma would be a great aid to a hybridizer at the time of emasculating the flowers. Nor would it be of less importance to a cultivator in the dry-farming tract. Other conditions remaining the same, the species that are narrow-leaved and hairy might be preferred to those that are broad-leaved and glabrous, for the simple reason that the trnaspirational loss of water in the latter would be more than that in the former.

I *Paspalum Scrobiculatum* (Kodon) (T. 43—Nagpur)

Root :—The roots are lean, thin and shallow-spreading. All of them arise from the bottom of the stem and each in turn gives rise to several secondary roots.

Stem :—The culm is more flat than oval. The nodes are prominnent and ringed. The first internode is about 1″ long and the length of the subsequent internodes goes on increasing until, at the apical end, the internode measures nearly 3-5″. The stem on the whole, appears pigmented with a pink colour, though actually it is not the axis of the stem but the overlapping leaf sheaths that are pigmented. The basal leaves are more pigmented than the apical ones; Out of the leaf, the sheath is more so than the lamina. The stem is not perfectly hollow but consists of a well-developed prominent white soft pith. Within one or two nodes from the basal portion, branches some-times arise at the axils of the leaf sheaths. These branches also bear ear-heads besides those borne by the main plant. On an average the plant is nearly 2½ feet high.

Leaf:—The lamina is lanceolate with pigmented entire margins. The apex is acuminate and prominently pigmented. The lamina is rough when felt from apex towards the sheath and is fairly smooth when felt in the reverse direction. The venation is parallel. The leaf sheath extends to about half of the next internode, there being a white prominent demarcation at the spot corresponding to the situation of the ligules in other allied millets. The ligule is alomost smooth consisting of a very few hairy outgrowths.

Tillers: —The tillers are thin and are also pigmented pink. The number of tillers varies from 2 to 10. The mode being 5. But even plants without tillers occur. Each tiller bears an ear-head.

Inflorescence:—The inflorescence is panicle of spikes. The peduncle is rather slender and triangular. The side branches or spikes bear the spike-lets and are narrow flat pads with spike-lets embedded on one side, only in two rows. (In some species three rows of spike-lets are also seen.) The spikes are 2 to 8 in number, nearly 2" long, alternate, errect or spreading.

The spike-lets are in two rows" imbricate, glabrous or sparsely pubescent, some-times germinate on a common pedicel. Each spike-let consists of four glumes, though the middle ones are regarded as lemma and palea of the fertile flower.

The androecium consists of three stamens. The anthers are fairly long, yellow in colour and are basifixed. The gynaeceum colour consists of a single ovary with two stigmas, free, hairy or bushy. There are two fleshy lodicules present on either side of the ovary and these are supposed to aid in pollination.

Fruit:—The grain is flat and oval with a pale, dull black coat which is nothing else but the hardened convex lemma and palea of the fertile flower. It is endospermic. The hilum is white in colour.

II Setaria italica (Kangni) T. 87—Nagpur)

Root:—The roots are of two types (i) those that are underground and (ii) those that arise from the nodes of the aerial shoot the underground roots are almost as stout as those of Panicum miliare, but spread less and extend to a less depth into the soil. The primary roots arise from the bottom of the stem and give rise to secondary roots, each of which in turn gives rise to several tertiary roots. The adventitions roots are stouter, yellowish green rather than white, fleshy and brittle with round apices. Some of them grow long enough to enter into the soil and fix the plant and also are said to supply food material thus acting as normal roots.

Stem :—The culms are round and hard with prominent nodes, smooth rings being formed at those spots. The first basal internode is nearly 1½" long and the length goes on increasing up to 3" towards the apical end where the nodal rings are not very prominent. The stem is not hollow, but has a fairly well-developed hard pith. The average plant is about 3¼" high.

Leaf :- Tha lamina is broad (about 1¼") in the middle gradually tapering and narrowing down towards the apex. It is lanceolate; margin is entire and apex acuminate. Venation is parallel. The leaf is smooth when felt from the basal to the apical end, but is rough when felt the other way. The leaf sheath is very prominent, arises at one node and extends up to the middle of the third internode where the leaf blade originates. There is a prominent, white, hairy ligule at the junction of the leaf blade and leaf sheath.

Tillers :— Nearly 50% of the pants do not tiller, but in those which do, there are 2 to 7 tillers, three being of common occurrence. Each tiller bears an earhead.

Inflorescence :- The inflorescence is simple panicle. It is terminal, usually compact, sometimes loose, cylindrical ends often tapering and is borne on a thin peduncle. It is made up of small rounded branches, the spikes arranged in 3 to 5 spiral whorls along the rachis. Each of them bears the spike-lets—the floral units. The spike-let is borne on thin, very short pedicels, slightly swollen at the junctions Each spike-let is surrounded at the base by a number of bristles which are thin and stiff. They morphologically represent the barren floral branches.

There are two glumes at the two extremities varying in size. Enclosed by these are a sterile flower consisting of a lemma and a palea, and a fertile flower. The androecium in the latter consists of three stamens borne on slender filaments. The anthers are yellow, long, bilobed and basifixed. The gynaeceum consits of two feathery stigmas with a basal hyaline ovary. There are two lodicules situated on either side of the ovary.

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*T. 38 B—Nagpur

Fruit :—It is small, free, but tightly enclosed within the thickened glume and palea. It is endospermic and is dull yellow in colour.

III **Eleusine coracana* (Ragi) (T. 38 B—Nagpur)

Root :—Its roots are stouter than those of Panicum miliare. They arise from the base of the stem and spread shallow in the soil. The primary roots give rise to secondary roots, each of which in turn gives rise to tertiary roots.

Stem :—The culm is flat and has got a very well-developed white pith. A greater bulk of the stem appears to have been made up of the leaf sheaths. It is an exceptional case, where from the same node, 6 to 8 leaf sheaths arise, one overlapping the other. The first internode is about 1″ long and the subsequent ones abruptly jump up to 2″ or even more in length. The plant is about 2½ feet high

Leaf :—The lamina is more or less broad gradually tapering to a point towards the apex. The lamina is lanceolate, margin entire and apex acuminate. At every node, at the axil of the first leaf sheath there appears a small rudimentary branch. The leaf sheath gradually merges into the leaf lamina, a prominent hairy ligule being present at their junction. Venation is parallel.

Tillers :—Tillering is very poor and rare. Many of them are single plants, though occasinally, they tiller.

Inflorescence :—The inflorescence is of different shapes and may be top-curved, incurved, fist-like, long open, short open or very short open. It, unlike all the other cereals, consists of a whorl of fingers—the spikes of the inflorescence. Each spike has an innumerable number of spike-lets arranged in a varying number of regular lines. All these spike-lets are borne on a rectangular rachis, they being arranged on one side only, the other side of the rachis remaining blank.

Each spike-let has 4 to 6 flowers, 5 being the most common. There are two sterile glumes at the two ends with five flowers in the middle. Each flower has its corresponding lemma and palea enclosing the sexual organs. The sexual organs consist of three stamenes with yellow, long, bilobed and basifixed anthers, and one ovary with two feathery stigmas. Each ovary has two lodicules on either side of it, thus there being ten lodicules for five flowers in a single spike-let.

Fruit :—It is small, more or less round and is reddish brown in colour. There is a black spot just near the hilum. The fruit is enclosed by the hardened lemma and palea and is endospermic.

IV Panicum miliare* (Kutki) (T. 70 Nagpur)

Root :—Its roots run relatively deeper. They are fairly long, bushy and are stouter than those of Paspalum scrobiculatum though narrower than those of Eleusine coracana. These are the primary roots which arise from the bottom of the stem. They give rise to many secondary roots each of which in turn gives rise to several tertiary roots.

Stem :—The culm is more towards flat than round. The nodes are ringed and well-developed. The length of the first internode hardly exceeds 1½", but the very subsequent upper internode is nearly 3" long and this length is maintained till the apex is reached where the length decreases to about 2-5." The stem is hollow with a uniform bore right through except at the nodes where it is solid. The average plant is about 3' high.

Leaf :—The lamina is lanceolate, margin sharpand entire, apex acuminate and venation parallel. The leaf blade is rough when felt from apex to base, but smooth, when felt the other way. The leaf sheath is prominent, open and smooth, but does not extend to more than a single internode. The leaf arises at one node and the leaf sheath runs up to the consecutive node enclosing the internode completely and the leaf blade originates exactly where the sheath reaches the latter node. The ligule is grey in colour and consists of membranous flaps.

Tillers :—The tillers are thin, slender and are not pigmented. The no of tillers varies from 8 to 22, the average number being 1 . But in certain exceptional cases, even 4 tillers per plant occur. Each tiller bears an an eachead—long or small.

Infloreseence :—It is a sub-panicle of spikes and is 2"—10" long; the lower branches or spikes are fairly long. The pedicels of spike-lets are sometimes ½" long. The spike-lets are glabrous, rather flattened, usually green or purplish.

At the two extremities of a spike-let are two glumes enclosed in which are the lemma and palea of a sertile flower, and lemma and plea of a fertile flower with the sexual organs. The androecium consists of three stamens, the anthers of which are long, bilobed, yellow and basifixed. The gynaeecum consists of two feathery stigmas borne on a single ovary. There are two fleshy lodicules on either side of the ovary facilitating pollination.

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* 70—Nagpur.

Fruit :—It is spindle-shaped and has a shining pale black colour. The coat consists of the hardened lemma and palea of the fertile flower. It is endospermic.

V* *Panicum frumentaceum* (Sawan) T. 80–Nagpur.

Root:—The under-ground roots resemble those of Paspalum scrobiculatum only with this difference that in this case there are tertiary roots also to be found. The roots are a bit longer going deeper into the soil. There are also aerial roots shooting down from the nodes some of them even entering the soil.

Stem:—The culm is more flat than oval and is hollow inside. The internal core is covered with a loose net work of pith. Branches frequently arise from the basal nodes which also bear inflorescences. The basal portion of the stem is slightly pigmented. The first or the basal internode measures a little over 1″ and its length very steadily but gradually increases up to 6.″ The plants are errect, some-times decumbent at the base and often reach a height of 3½.′

Leaf:—The lamina is linear and the upper surface is hairy. The base of the leaf sheath originates at one node and ends in the middle of the next internode. The leaf sheaths are open. The ligule is absent.

Tillers:—The tillers are pigmented reddish brown at the bottom. These also give rise to branches at their nodes as have been observed in certain cases and ærial roots shoot down from the place of origin of such branches. The unmber of tillers is 3 to 18, the number of common occurrence being 8. Each tiller bears an earhead.

Inflorescence :—This is rather a sparse panicle 4–"10" long; the erect branches are some-what angled and rough. The branches of the panicle spread in in all sides. The spike-lets are oval in shape and each of them consists of two glumes at the two extremities. These enclose within them a lemma and a palea of a sterile flower, and a lemma and a palea with sexual organs of a fertile flower. There are three stamens, the anthers of which are long, Yellow and dorsifixed. There are two plumose stigmas. The two lodicules present on either side of a single ovary are fleshy, smooth and some-what broader than long.

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* 80—Nagpur.

Fruti :—It is pale yellow or white and shining. It is enclosed by the hardened lemma and palea of the fertile flower. It is endospermic.

Pollination :—Generally the middle flowers open first, the bottom ones next and top ones last except in setaria italica where the top ones open first and the bottom ones last. The flowers of Eleusine coracana are not observed to open during day time and may naturally be opening during night time. As regards the actual process of pollination, all the species could not be studied due to lack of time at the disposal of the author. The pollination of Paspalum scrobiculatum only could be studied in detail and hence is given below.

Although the flowers of Paspalum scrobiculatum have been referred to as cleistogamous by certain workers, yet some of them have been observed to open just before the actual act of pollination. Only about 5% of the flowers open, these opening between 7-30 and 8 A. M Six flowers have been observed to open during this period. The glumes remain so for 25 miuutes. Immediately after the opening of the glumes, the anthers burst with a certain amount of jerk and remain in their original position The feathery stigmas spread out on either side thus causing the pollination.

CONCLUSION.

The investigation undertaken does not pretend to be a perfect one and nothing should emerge as a conclusive statement unless it is corroborated by further trials.

The author's experience has shown that it is not very difficult to record vegetative characters of these millets. But the study of the floral characters requires both experience and skill. The dissection of the spike-lets is a delicate operation, but can be successfully performed with a little practice. Amongst the vegetative characters recorded, it is of interest to note that all except Panicum frumentaceum possess a ligule at the junction of the leaf base and leaf lamina. Further, under the existing climatic conditions of Nagpur, all of them except Eleusine coracana tiller well. The tillering capacity of these millets has a direct bearing on the yield and therefore needs improvement by breeding.

A morphological study of this nature reveals that each millet especially setaria italica and Paspalum scrobiculatum are an assemblage of various economic morphological characters. Hence several unit types could be evolved and selected to raise the yield of these millets. In corroboration of this statement, it may be added that setaria italica especially is a mixture so far as the height character is concerned. Similarly if the length of the inflorescence would have been taken into consideration the auther would have got different frequency curves. From this, therefore, several economic types can be evolved.

Improvement, as far as possible, should be made by selection based on the study of the nature undertaken. In case the desired object has not been attained, it is necessary to take recourse to the process of hybridization. It is worth while to try inter-generic and inter-specific crosses. The hypothetically ideal cross expected to be evolved from theoretical considerations by hybridizing setaria italica with Panicum miliare would be undoubtedly a great asset to the cultivator.

(Readers interested in the–photographs figures and bibliography relating to this article may please refer to the author.)

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Studies in the Grams of C. P. and Berar.

II

The inheritance of some characters in gram (Cicer-arietinum L)

By

E. D- Pimplikar, B. Ag. (Nag.)

1. *Introduction*:—

Among the pulse crops of the province gram occupies by far the largest area. The acreage occupied by the different pulses in the province is as follows:—

Crops.		*Acres*.
1. Gram	....	1,181,184
2. Urid and Mung	....	1,455,403
3. Lakh	....	1,048,874
4. Tur.	....	7,38,183
5. Masur	....	2,88,027
6. Others	....	1,89,301

It is cultivated all over the province, though the dense producing areas are in the Northern tracts.

It is needless to point out the importance of this pulse in human consumption as well as in cattle ration. Besides as rotational crop for enriching the soil in its supplies of organic nitrogen it has a great importance.* It is estimated that the provincial demand for this pulse is about 16,000 tons—about 39 % of the quantity being Gulabi D 8. Parched gram is extensively consumed and the demand is especially keen in the cotton tracts. About 1/12th of the total area under gram in the province is under D 8 and the acreage is gradually increasing.* Among the selections introduced by the department D 8 is the best so far as the frying quality is concerned, and as such it fetches a higher premium over the rest. The other selections of the Department Nos. 28, 62 and 352 though high yielders are however less valued in the market—

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* Data kindly supplied by the Deputy Director of Agriculture Economics and Marketing C. P. Nagpur.

because of the poor frying quality.* D 8 even though highly priced yields very low in the field. It was therefore thought to combine the frying quality of D 8 with the high yield of No. 62. Subsequently it was also decided to under take the study of the inheritance, of some qualitative characters found in the varieties (D 8 and No. 62) which forms the subject matter of the paper.

2. *Previous literature:—*

Shaw[4] (1927-29) and Alam[1] (1935) have found out the close co-relation between the seed colour and shape as also the linkage between the flower colour and seed colour. The seed colour and shape depend upon the interaction of four factors. the same factors which determine the colour of the seed being responsible for the shape. They indicated that brown red shades were produced from plants with pink flowers and white or orange seeds from white flowered types.

Khan and Akhatar[2] (1934) studied the inheritance of petal colour in the Imperial Pusa types and stated that 1. a factor i.e. B is responsible for the blue colour of the petals.2. that when this factor B is in association with another factor P the flower colour is pink.3. that in the absence of B the flower colour is white irrespective of the presence or absence of P.

Hukumsing and Ekbote[3] (1936) studied the inheritance of colour, shape, and surface of the seed in the crosses among Pusa types 11,12, 52 and 21. It is pointed out by them that shape, colour and surface of the seed are all associated.

Group. I. The yellowish brown and dark reddish brown seeds are linked with irregular seed shape and slightly granulated surface. Group II. The bluish brown colour of seed is linked with round shape and smooth surface.

Group III. Pink flower colour is linked with yellowish brown or reddish brown seed and blue flower colour with bluish brown seed.

V. Ramnath Iyyer and R. Balasubramanian[5] (1936) have pointed out that the pink colour of the flower is a combination of three factors P,C and B. They further stated that the factor B has manifold effect on the flower. It imparts blue colour to the petals when it is in association with C and pink in the combined presence of C and P–The petals are white when it is absent.

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* Deputy Director of Agriculture, Northen Circle C. P. Report on demonstration work 1935."

3. *Material and methods:—*

The best of the high yielders of the locality No. 62 was selected as one of the parents for crossing with D 8 in the year 1935, at the Agricultural Research Institute, Nagpur, under the guidance and help of Mr. K. P. Shrivastav, the then Second Economic Botanist, C. P. and as the flowering periods of both the varieties were coincident, no difficulty was experienced in the technique of effecting a cross.

In gram the opening of flowers takes place in the morning at about 9-30 a.m. and remains so till 4-0 p.m. In emasculation of buds, the method suggested by Khan and Akhatar[2] (1934) was followed. The bunds are fond to be very delicate. The percentage of setting was found to be 12.

The contrasting characters of the parental types along with F_1. are described below :—

Parents and F 1	Flower colour.	Seed colour	Seed shape
No. 62	Pink.	Yellowish brown.	Irregular.
(Gulabi) D 8	White.	Orange yellow.	Round.
D8 x No. 62 F1 (8 plants)	Pink.	Yellowish brown.	Irregular.

It is clear from the above table that in F 1 generation.

a. pink colour of the flower is dominant over the white
b. yellowish brown colour of the seed is dominant over the orange yellow
c. irregular seed shape is dominant over the round.

4. *Results of the F 2 generation :—*

1. *Flower colour–*

The following segregations were observed in F 2.

Flower.	Frequencies. observed.	expected.	
Pink	129	131.25	
White.	46	43.75	$x2 = 0.1542$; $n = 1$; P between 0.7 to 0.5

The fit is excellent.

It is thus clear that pink flower colour shows a unit factor difference over the white.

2, *Seed colour.—*

The following segregations were found in F^2.

Seed colour.	Frequencies, observed.	 expected.	
Yellowish brown.	129	131.25	$x^2 =$ O. 1542; n = 1; P. between O. 7 to O. 5.
Orange yellow.	46	43.75	

The fit in this case also is good, and shows a single factor difference.

3. *Shape of the seed.*

In F_2 generation the following results were obtained :-

Shape of seed.	Frequencies. observed.	 expected.	
Irregular.	133	131.25	x^2 = O 0933; P between 0.7 to 0.5.
Round.	42	43.75	

This is a simple monohybrid ratio indicating thereby that one single gene is responsible for the appearance of irregular shape character of the seed.

4. *Flower colour and seed colour.*

In F_2 the following segregations were obtained, with respect to flower colour and seed colour.

Colour of the flower and seed.	Frequencies. observed.	 expected.
1. Pink flower and yellowish brown seed.	129	98.43
2. Pink flower and orange yellow seed.	0	32.82
3. White flower and yellowish brown seed.	0	32.82
4. White flower and orange yellow seed.	46	10.93

The parental combinations have beeen realized much above the expectations, the recombinations have not been realized which indicate a complete linkage between the colour of the flower and the seed.

5. *Flower colour and shape of the seed.*

In the F_2 generation the following segregations were observed with respect to flower colour and shape of the seed together.

Flower colour and shape of seed.	Frequencies. observed.	expected.	O-C	$\frac{(O-C)^2}{C}$
1 Pink flower with irregular shape of seed.	97	98.43	—1.43	0.020
2 Pink flower with round shape of seed.	32	32.8	—0.81	0.019
3 White flower with irregular shape of seed.	36	32.8	+3.19	0.308
4 White flower with round shape of seed.	10	10.97	—0.97	0.085V
				0.432.

$X^2 = 0.43$;
P between 0.95—0.90.

The fit in this case is good, and the two characters being inherited independently, the appearance of the different phenotypes into dihybrid proportions is clearly brought about.

6. *Colour of the seed and shape* :—

If these two characters are taken together for consideration of inheritance, the sagregations into phenotypes are obtained in the following proportions :—

Colour of the seed and shape.	Frequencies. observed.	expected.	O—C	
1. Yellowish brown seed with irregular shape.	97	98.43	1.43	
2. Yellowish brown seed with round shape.	32	32.81	0.81	
3. Orange yellow seed with irregular shape.	36	32.81	3.19	$X^2 = 0.43$; P between 0.95 to 0.90.
4. Orange yellow seed with round shape.	10	10.97	0.97	

The fit is very good and indicates an independent inheritance of these two characters. The segregations into differant phenotyes clearly point out that two genes are certainly responsible for the two characters mentioned, and there can, possibly, be no suggestion of any kind of linkage in this particular cross.

Next we come to discuss the inheritance of three characters *viz.* flower colour, seed colour and shape of the seed together. Under ordinary three factor inheritance the expected frequencies of the eight phenotypes in the F 2 generation should have been in confirmity with the trihybrid ratio. But actually the four phenotypes *i. e.* pink flower with orange yellow irregular seed, pink flower with orange yellow round seed, white flower with yellowish brown irregular seed and white flower with yellowish brown round seed were not obtained. The expected and absered frequencies are shown in the following table :—

	Pink flower				White flower				
	Yel. Bro. irregular	Ora Yel irregular	Yel Bro. round	Ora. Yel. round	Yel. Bro. irregular	Ora Yel. irregular	Yel. bro. round	Ora. Yel. round	$\frac{(O-C)^2}{C}$
Expected	74.19	24.73	24.73	8.21	24.73	8.21	8.21	2.73	
Observed	97	0	32	0	0	36	0	10	
Ratio	9		3		3		1		
Expected Ratio .... Observed.	8.69		3.19		3.19		1.95		n....3 X^2.... O.43, P between 0.95 to 0.90

As seen from the calculations the fit between the observed and the expected is close and suggests a perfect linkage between the flower colour and the seed coat colour and the shape of the seed and colour inherit independently.

Discussion of the results :—

The pink colour of the flower is formed by a combination of two complementary factors *viz.* P and B as found by Khan and Akhtar (2) (1934) and by three factor combination as theorised by V. Ramnatha Ayyer and R. Balsubramanium (5) (1936) *viz* P, C and B. In the former case we can not assume the other parent to be recessive for all the factors *viz.* pp bb for in that case we should have got a blue pheno-type in F 2 generation. It is as follows :—

Parent PP BB x pp bb
(pink) | (white)
Pp Bb Fl
(pink)
|
F_2

PB	pB	Pb	pb
9 (pink)	3 (Blue)	3 (white)	1 (white)
9 :	3	: :	4

It is obvious from the above that the ratio is a modified digenic one i.e. 9 : 3 : : 4 and no ratio of the kind was obtained.

The only genic formula that we can postulate on the results got must inevitably contain the factor P in the double dose in the F_1 generation which would inhibit the apperance of any blue phenotype in F_2. This is possible only by the recessive parent containing the factor P. The segregation, then, would be as follows :-

PP BB x PP bb
|
PP Bb (Pink) F_1
|
F_2

$$\underbrace{\begin{matrix} PB & & PB \\ 1 & & 2 \end{matrix}}_{3 \text{ (Pink)}} \qquad \underset{1 \text{ (White)}}{\begin{matrix} Pb \\ 1 \end{matrix}}$$

This is in complete agreement with the results obtained.

In case we assume pink colour to be a three factor combination as observed by the latter authors, the white recessive may be of any one of the following genic constitutions.

White parent	Pink parent	Remarks.
(1) pp c c B B (2) pp CC b b (3) pp c c b b	× PP CCBB	This will throw a blue pheno-type in F_2
(4) PP c c b b ×	PP CCBB	This will give a 9:7 ratio in F_2
(5) PP c c B B (6) PP c c b b	× PP CCBB	This will give a 3:1 ratio in F_2

The pink parent will have PP CC BB as its genic constitution. If this pink is crossed with any of the first three genotypes, the F_2 segregation will necessarily contain a blue pheno-type. In our results however no such blue pheno-type was obtained. Therefore the constitution of the white parent as mentioned in the first three cases is out of consideration. The formula No. (4) is also out of question since the ratio obtainable by it is a modified digenic one which is different from our results. The formulae Nos. 5 and 6 give results in agreement with those obtained, indicating thereby that the recessive parent D_8 (Gulab's gram) lacks in one gene, either B or C.

On the assumption of the theory of Khan and Akhtar the constitution of the parents can be expressed as follows :-

P P B B Ir Ir—No. 62 P P b b ir ir—D 8.

B—gives blue colour to corolla.

P—modifies the action of B turning blue flower to pink. By itself it is ineffective and produces white flower.

Ir—In presence of "Ir" the seed shape is irregular while in its absence it is round. It is unaffected by the seed shape properties allotted to P, B or A. or Fr.

Flower colour :—

38 cultures selected at random in F_2 behaved as follows in F_3 with regard to the colour of the petals.

Number & nature of F_2 parents.	Behaviour in F_3 generation.	Constitution in F_2 geno-type.	Freq, Obs.
30 pink flower colour	Pure	PP BB	10
	Segregating lik F_2	PP Bb	20
8 white flower colour	Pure	PP bb	8

The breeding behavour in F_3 confirms the results obtained in F_2. This is in agreement with the results obtained by the previous workers.

Seed coat colour :—

38 cultures selected in F_2 showed the following behaviour in F_3 :—

Number & nature in F_2 parent	Behaviour in F_3 generation.	Constitution in F_2 gene.	Freq.
30 culture with yellowish brown seed	Pure	PP BB	10
	Segregating like F_2	PP Bb	20
8 cultures with orange yellow seed	Pure	PP bb	8

So far as the seed coat colour is concerned the results as obtained are in close agreement with those of Alam (1938). Thus the basic colour of the seed is orange yellow and the factor P has no effect on it apparently. Factor B in combination with P produces brown or red colour-action.

Shape of the seed :—

The behaviour in F_3 generation of 38 cultures so far as this character is concerned is given in the following table:-

Number & nature in F_2 parent.	Behaviour in F_3 generation.	Constitution in F_2 generation.	Freq. obs.
30 cultures with irregular shape of the seed.	Pure	Ir Ir	10
	Segregating like F_2	Ir ir	20
8 cultures with round shape of the seed.	Pure	ir ir	8

This clearly shows a simple case of one gene being responsible for the appearance of this character. The results obtained in F_3 are in full agreement with those of F_2.

Flower colour and the colour of the seed:—

If these two characters are taken into consideration together for the study of inheritance the segregations of 38 cultures into different pheno-types are obtained in following proportions in F_3—

Number & nature of F_2 parents.	Behaviour in F_3 generation.	Constitution in F_2 generation	Frequencies Obs.
30 cultures with pink flower and	Pure	PP BB	10

Number & nature of F_2 perents.	Behaviour in F^2 generation	Constitution in F_2 Generation	Frequencies observed.
yellowish brown seed.	Segregating like F_2	PP Bb	20
8 cultures with white flower and orange yellow seed.	pure	PP bb	8

In none of these we could get pink flower with orange yellow or white seed and white flower with yellowish brown or red seed, and clearly suggests a perfect linkage between the flower colour and seed coat colour. The results thus agree completely with those of Shaw[4] (1928-29) and Alam[1] (1935).

Shape and colour of the seed:—

When these two characters are taken together for consideration for inheritance, the segregations of the 38 cultures in F_3 into different pheno-types are obtained in the following proportions:—

Number & Nature of F_2 parents.	Behaviour in F_3 generation.	Constitution in F_2 generation	Frequencies Obs.
24 cultures with yellowish brown seed and irregular shape.	Pure	PP BB Ir Ir	4
	Segregating like F_2 for both characters.	PP Bb Ir ir	11
	Segregating for shape	PP BB Ir ir	4
	Segregating for colour of the seed	PP Bb Ir Ir	5
6 cultures with yellowish brown seed and round shape.	Pure	PP BB ir ir	2
	Segregating for the colour of the seed.	PP Bb ir ir	4
6 cultures with orange yellow, irregular shape of the seed.	Pure.	PP bb Ir Ir	1
	Segregating for shape.	PP bb Ir ir	5
2 cultures with oragange yellow, round seed.	Pure	PP bb ir ir	2

· Twenty-four cultures from yellowish brown seed and irregular shape with pink flower were grown in F^3. Out of these four cultures bred true and the 11 sugregated for colour of the seed and shape as follows:--

Culture No	Yellowish brown Irregular.	Yellowish brown Round.	Oranger Irregular	yellow Round.	Total number of plants.	X^2	Value of P
1	12	4	7	2	25 2.859 50 to 30	2,85	0.50-0.30
12	20	3	4	3	30	5.59	0.20.0.10
32	21	8	7	1	37	0 91	0.90-0.80
40	13	4	5	0	22	1.59	0.70-0.50
59	20	5	6	3	34	0.72	0.90-0.80
65	20	7	5	1	33	0.98	0.90-0.80
81	34	11	13	3	61	0.40	0.95-0.90
99	22	7	8	2	39	0.15	0.99-0.98
131	16	8	50	4	33	2.91	0.50-0.30
155	10	7	9	1	27	5 85	0.20-0.10
156	22	3	4	2	31	3.12	0.50-0 30
Total observed	210	67	73	22	372		
Expected on 9:3: ·3 1	209.25	69.75	69.75	23.25	372		

$X^2 = 0.325, n = 3.$ P between 0.98 to 0-95

Out of the above 24 cultures, 4 cultures segregated for shape only as follows :-

Cultnre No.	Yellowish brown Irregular	Yellowish brown Round.	Total uumber of plants	X^2	Value of P
15	41	13	54	0.02	0.90-0.80
34	21	6	27	0.39	0.70-0.50
78	15	5	20	0.00	1
155	12	5	17	0.17	0.70-0.50
Total observed.	89	29	118		
Expected on 3:1 ratio.	88.5	29.5	118		

$X^2 = 0.01,$ $n = 1.$ P between 0-95 to 0-90

The remaining 5 cultnres segragated for colour of the seed as follows :-

Culture No.	Yellowish brown seed.	Orange yellow seed	Total No. of plants.	X^2	Value of P
28	22	6	28	0.18	0.70-0.50
41	14	5	19	0.01	0.90-0.80
47	16	9	25	1.61	0.30-0.20
121	27	7	34	0.35	0.70-0.52
174	18	6	24	0.00	1
Total observed	97	33	130		
Expected on 3:1 ratio	97.5	32.5	130		

$X^2 = 0.009, n = 1.$ P between 0.95 to 0.90

Six cultures grown from yellowish brown seed with round shape were raised in F_3. Out of these two bred true and the remaining four segregated for colour of the seed as follows:—

Culture No.	Yellowish brown seed	Orange yellow seed	Total No of plants.	X^2	Value fo P
22	14	4	18	0.07	0.80-0.70
33	16	6	22	0.06	0.90-0.80
56	15	4	19	0.15	0.70-0.50
111	21	7	28	0.00	1
Total observed	66	21	87		
Expect on 3:1 ratio	65.24	21.75	87		

X^2 =0.028, n=1. P. between 0.90 to 0.80

From among the six cultures with orange yellow, irregular shape, one bred true and five segregated for shape as mentioned below in F_3:—

Culture No.	Orange yellow seed Irregular	Round	Total No. of plants	X^2	Value of P
4	45	15	60	0.00	1
23	24	9	33	0.09	080-0.70
48	14	5	19	0.01	090-0.80
96	11	4	15	0.02	090-0.80
109	7	1	8	.066	050-0.30
Total observed	101	34	135		
Expect on 3:1 ratio	101.25	33.75	135		

X^2=0.0016, n=1 P between 0.95 to 0.90

The results obtained in this particular case are different from those of previous workers. Shaw (4) 1928-29 and Alam (1) 1935 and Hukum Sing and Ekbote (3) 1936 have all printed out that "Colour and shape factor of the seed were probably linked."

With this assumpation, however, the seed coat colour of the white parent must necessarily have irregular shape since the function allotted to the factor P in the article of Hukum Sing and Ekbote is to convert round shape to irregular in presence of A or B. This part, however, does not seem to hold good in the present case since the white parent has round shape.

As per V. Ramanatha Ayyar and R. Balasubramanian the white parent must contain. Fr to have round shape. The white parent in both the Cases Nos. 5 8 6 must contain Fr to give round shape; but with this constitution the appearance of round Shape in F^1, is inevitable which was not observed in the present case. These results therefore can only be accounted for by the presence of a dominant *Irregular* "Ir" which is present in the pink parent and which is unaffected by the properties allotted to A, B or P by Hukum Sing and Ekbote and Fr and B by Ayyar and R. Balasubramanian; and that the two genes are certainly responsible for the two characters mentioned and that there can possibly be no suggestion of any kind of linkage between the two.

Next we come to discuses the inheritance of three characters namely flower colour, seed coat colour and shape of the seed together. The results of the F3 generation are exactly similar to those obtained in seed coat colour and the shape since the flowe-colour and the seed coat oolour are perfectly linked. Under ordinary three factors inheritance the expected frequencies of the eight phenotypes should have been in confirmity with trihybrid ratio; but actually the four phonotypes namely pink flower with orange yellow irregular seed; pink flower with orange yellow round seed; white flower with yellowish brown or red irregular seed and white flower with yellowish brown or red round seed were not obtained. This gives a clear proof of the fact that flower colour and seed coat colour are linked and that shape character of the seed is inherited independently and is not associated in any way with the seed coat colour as pointed out by Hukum Sing and Ekbote (3) 1936.

(*Summary* :-)

The inheritance of flower colour, seed coat colour and shape of the seed in gram has been studied in a cross between D8 X No. 62.

The inheritance of flower colour shows that pink colour is dominant over white, and irregular seed shape over round and brown or red seed coat over orange yellow or white in a simple monohybrid ratio of 3: 1.

Flower colour and seed coat colour if taken together point out clearly a perfect linkage between the two. Pink flower will either produce yellowish brown or red seed coat and white flower with orange yellow or white seed coat. Seed colour and the shape are inherited independently and the ratio is a clear digenic one and points out to no such correlation, The results of this inheritance are further substantiated by the inheritance of three characters, that is, flower colour, seed coat colour and shape together. Instead of trihybrid ratio we get a digenic one.

* * *

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MAIZE

(With special refrence to the economic aspects of its cultivation.)

By : Dhannalal, Esq.

Maize is one of the most important cereals that are used as food grain crops in the World. It furnishes food for the great portion of the population of the American continent where it is known as 'Indian corn'. It is pre-eminently the grain crop of the U. S. A. Although maize is grown under a wide range of climatic conditions in different parts of the globe, the most favourable environments for its growth are found in a relatively restricted area of the U. S. A. where it has practically reached perfection. This particular part of the country is known as the corn-belt and contains a cheap, rich and well drained soil with a fair proportion of humus. The corn-belt really comprises that region in which the mean temperature in Summer (during its growing period) is between 70° and 80° F. and the night-temperature averages approximately to 60° F, in which the duration of the period of first is more than 140 days and the annual rainfall is from 25 to 50 inches, of which at least 7″ occurs during July and August. In the English and other European markets, it is spoken of as Indian Corn, as the first European settlers in America found it to be the chief bread making corn of the Red Indians or "Red men of the West".

History :— The actual origin of the plant is uncertain. It was probably first cultivated in the high plateau regions of the Central or Southern Mexico, where its cultivation was started somewhere at the beginning of the Christian Era. This part of Mexico is the native habitat of Teosinte (Tripsacum doetyloides) and Gama Grass (Euchaene Mexicona), which are closely related botanically to to maize and are growing wild in Mexico even today. It is highly probable that maize and these two other plants originated from a common ancestor which grew in Mexico at a remote period. It is reported that soon after its introduction, its cultivation spread rapidly north-wards and south-wards, reaching Rio Grande about 700 A. D. and Maine about 1,000 A. D.

Maize, it is said, was already under cultivation when Columbus discovered America in 1492. Soon after the discovery of the New World, the plant was introduced into the Eastern Hemisphere. Now it is extensively cultivated in the Southern Europe, Africa, Asia and Australia. It was introduced in India by the Portuguese settlers sometime in the 18th century. At the beginning of the 18th century, it was grown only as a luxury crop in the gardens of rich men, but later on its cultivation spread rapidly as a field crop all over the country, as its usefulness as a quick growing grain and fodder crop and its capacity to grow well in a variety of soil and climatic conditions began to be appreciated rapidly. It is now being grown all over India on an extensive scale mainly as a grain crop. The unripe cobs with grain in milky condition, especially of the yellow varieties which contain the fat soluable vitamin, are highly palatable and nourishing when eaten in roasted condition and are a popular article of delicacy realised by the rich and poor alike.

General:—Seeds of maize have low vitality unless they are stored in dry and air-tight receptacles. Seedlings usually start coming up on the third day after sowing, under favourable conditions. The majority of the seedlings however, come out on the fifth or the sixth day, while from the tenth day onwards they cease to germinate. The rate of vegetative growth is not uniform but varies with different varieties. Its growth is very slow at the beginning and very rapid after a fortnight or three weeks. The maize plant as a rule, does not tiller, the length of the stalk varying from 4 to 12 ft. depending on the variety, the richness of the soil and the climatic conditions. Different varieties flower at different periods of their growth. The early types start flowering in about 5 weeks, the medium, in 7 weeks and the late ones in about 8 weeks. In general, the male spikes appear first and the cob with its tussel of stigmas come out later, while in very few cases both come out simultaneously. The maize is naturally a cross pollinated crop, hence, the varieties or selected strains cannot be maintained pure when sown side by side. The plants bear the cobs at a height of 1½ to 3 ft. from the ground. The number of cobs produced varies from 1 to 4 per plant. Usually however, one and sometimes two are found. When more than two are produced, they are generally of small size and are not well developed. Good cobs are obtained when only one is produced from a single plant. Hence the production of two cobs per plant is economical. The grains of different sizes as well as of different shades of white, yellow, red, brown, spotted, and black are densely and regularly embeded on a thick and spongy axis. The early varieties in India ripen in about 60 days, while the late varities in 100 days. In America, however, it takes more than 150 days to mature. The maize plants have got adventitious roots above the soil which grow downwards and begin to function as absorbing roots when cobs are formed on the plants. Yellow seeded varieties contain more vitamins and are superior to the white ones which are supposed to have less.

The composition of the different cereals as given by Chamberlain (1909) with total nutrients per hundred pounds on water free basis is given below:—

Grain.	Protein. lbs.	Fat. lbs.	Crude-fibre. lbs.	Carbohydrates. lbs.
Oats	13.76	4.33	12.20	66.39
Wheat	14.20	2.36	2.78	78.72
Rye	13.44	1.83	2.30	80.24
Barley	13.39	1.87	5.64	76.05
Maize	9.91	4.40	2.21	81.96

The average proportions of the different parts of the plant body in maize plant is given below.

Roots – 8%, Stalks – 24%, leaves 28%, sheaths or husk 12%, Grain 25%, cobs without grain 5% = 100.

On an average, the weight of 1,000 seeds is 6 oz. or so that $\frac{16 \times 1000}{6} = 2666$ seeds will weigt – one pound.

Economic uses of Maize:—

1. The unripe cobs with grains in milky condition are extremely palatable and nourishing when eaten in roasted condition. These are consumed as such by every one rich and poor alike.

2. The ripe grain is used for making bread and other preparations for human consumption, although the maize flour connot be easily made into bread and does not bake so well as wheat flour, as it does not contain sufficient amount of gluten. The grain when plentiful and cheap is also fed to cattle and other live-stock.

3. The grain of maize which contains more than four-fifths of corbohydrates, is used in the manufacture of starch which is very easily digestable and hence preparations made from it are used largely as food for children and invalids. (4) The maize stalks while green, form a nutritious fodder and may be fed as such or dried as such or used as silage. (5) The ash of the hulled cobs (without grain) contains 20% potassium carbonate like tobacco or plantain stems and may be used for making compost which forms a useful manure for Potatoes. (6) Glucose and grapesugar are obtained from its starch. (7) The embryo of maize seed contains 30 to 40% oil which when extracted is used for soap making and preperations of paints. (8) The dry maize stalk, unless utilised as cattle fodder, are often used for paper making. In Australia, it

is better adapted for that purpose than most other grasses. The paper made out of the maize stalk is of a very fine quality and is next to that made from² rags. Three hundred pounds of dead leaves of maize may give a hnndred pounds of paper of excellant quality. (10) The husk and pith are often used as packing materials.

Varieties :- There are quite a good number of varieties in maize which are classified into separate groups based on different characters.

(1) The primary classification is based on the variation of colour and the character of the seed. The colour variations commonly met with in the seed are (1) white; (2) Yellow (pale yellow or deep yellow) (3) orange; (4) red; (5) spotted; (6) mottled and (7) black. The last three are rarely found in India.

(2) The above varieties may be further classified into three groups according to the size of the grains :— (i) Large grained types with 1,000 grains weighing 8 to 10 oz.; (ii) Medium grained types with 1,000 grains weighing 6-8 oz. and (iii) Small grained types with 1,000 grains weighing 4-6 oz.

(3) These may further be subdivided into three groups according to the size of the cobs :— (i) Long headed types with cobs 8-10" inches long (ii) Medium headed types having cobs 6 to 8" long and (iii) Short types in which the length of the cob varies from 4 to 6 inches. The actual size of cobs however, with the above type depends to a considerable extent on thick or thin sowing.

(4) From the point of view of maturity, maize varieties may be classified into (i) early, (ii) medium and (iii) late ripening varieties.

(i) The early types flower in 30 to 40 days after sowing and their seeds become fully mature in about 60 to 70 days approximately.

(ii) The medium varieties start flowering in 40-50 days after sowing and are ready for harvest approximately in 80-90 days.

(iii) The late varieties commence to flower in 50 to 60 days after sowing and their grains mature in about 90-100 days.

The earlier varieties are as a rule of short stature and the height of the plant varies from 5 to 7 feet. Those which are intermediate in maturity are of medium height varying from 7 to 9 feet while the late types are the tallest of all and the plants are 9-11 feet high. It is evident, therefore, that there is a sort of correlation between the height and the maturity of the plants. The period of maturity advances as the height of the plants increase. Besides this the shorter plants yield less while the highest yielders are the tallest ones.

Selection of varieties for cultivation :— The choice of the variety of maize to be grown will depend upon the soil, locality, climate and the use which the crop is likely to be put to. It has been found by experience that the Jaunpur variety from United Provinces is more prolific in yield and well suited for the local conditions obtaining at Nagpur.

It requires a richer soil and better cultivation and is more suitable for localities near large towns where it can be grown on well manured lands under irrigation or early in June for the facility of selling the green cobs in the market long before the main crops of maize from the adjoining villages are able to come up in the market. It is a medium ripening variety and has large and tall plants about 9 ft. in height as compared with local types. The growth is luxuriant with longer and broader leaves. The plants bear good sized cobs at a height of 2½ ft. above the ground. The seeds are light yellow and fair, and large though less hard and hence are inferior in their keeping qualities when compared to the late varieties. The flour of the grain however, is as good as that of the deeper yellow variety. It is sweeter to the taste as some of its carbohydrate is in the form of sugar. This variety is superior to the American types for purposes of our local requirements and pays well under good cultivation.

Climate and season :—This crop requires a warm climate and a well distributed but copious rainfall during the whole of its growing period. Although it also thrives and is often grown, under a wide range of climatic conditions in the different parts of the globe, the most favourable environment for the economic growth of this crop is to be found in relatively restricted areas. It is susceptible to injuries through frosts and cold winds. It can be grown throughout the year under irrigation in India, if the mean temperature in the locality is above 60^0 F during its growing period. It is grown as a Kharif crop during the rainy season for its grains as well as its fodder and as a rabi crop under irrigation in winter time. Its fodder becomes available within two months and a half after sowing.

Soil :—Maize does exceedingly well on a rich, deep and well drained (either natural or artificial) soils containing a sufficient quantity of humus. The soil should be situated on a fairly high lying portion, so that no water-logging takes place at any time during its growing period, as the crop suffers badly from stagnant water. It is grown successfully on the Nagpur Farm on deep rich, retaintive loamy soils which however are artificially drained. The cultivators in these Provinces invariably plant maize in well manured areas attached to their dwelling houses or in garden lands which are usually well manured and contain a large quantity of humus. It is hardly ever planted in fields which are relatively less fertile and are far removed from the village site.

Mixtures : - The crop of maize is usually planted by itself, because its habit of rapid growth does not make it a good companion for subordinate mixtures. Occasionally, the garden cultivators grow it in sugar cane fields along with some of the gourd types in February or March when the sugar cane crop is usually planted. By the time however, the sugar cane crop comes to about a foot in height the maize finishes its life and is removed. Sometimes cow-pea is mixed with maize crops in the badis attached to the houses. On the Nagpur Farm however it is sown by itself.

Rotation :—The crop of maize does very well after a leguminous crop, as, being a cereal, it is especially fitted by the residual nitrogenous material left in the soil by the legumes. For the same reason it is usually grown mixed with cow peas which are marketted as green vegetables and is followed by tobacco or brinjal planted in October. In garden lands, it is often rotated with other vegetables crops, such as ginger, brinjal, cabbages etc. It is not considered to be a good thing for it to be planted before any garden crops to be grown in succession on the same land in the same year; being a very exhaustive crop. On the Nagpur Farm it is grown after berseem. i.e. maize and berseem are taken on the same land in succession every year and are, then, rotated with groundnut in two years course rotation.

Manure :—Maize is a quick growing crop, a high yielder and a gross feeder and hence requires to be manured very liberally. The manure to be applied in however, must be rational, so that the crop may get the plant food nutrients in an available form continuously throughout its growing period and that, too, always in sufficient quantities. The cultivators usually apply 4 tons of well decayed farm yard manure or compost or 10 maunds of Castor cake. Any of these may be applied just after the removal of the previous crop and the manure is either ploughed in by an inverting plough or well mixed with the soil by repeated ploughings and bakherings. On the Nagpur Farm, after the removal of the berseem crop, the land is manured with 6 tons of well decayed cattle dung in the month of April and ploughed in six inches deep with soil inverting plough. The manure becomes available for the crop sown in the first week of June. This quantity of manure mentioned above will supply 66 lbs of nitrogen, 30 lbs of P_2O_5 and 48 lbs of K_2O, while a crop of 3,000 lbs (50 bushels) of maize from one acre of land requires the following quantities of nitrogen and mineral nutrients.

Nitrogen :—30 lbs, P^2O_5 - 33 lbs, K_2O - 23 lbs, cao - 1lb,

Mgo-10 lbs, SO_3 - 21 lbs.

Preparation of seed bed :—A deep seed bed is very beneficial to the crop because the roots have been found going 8 feet deep and spread laterally 4 feet wide. It may be obtained by ploughing with a heavy soil inverting plough. If heavy iron plough is not avilable, four to six ploughings and cross ploughings with the heavy wooden country plough are given. Before sowing however, two bakherings and a cross bakhering may be given with a view to get fine seed bed, as maize requires a deep soil with fine tilth. The stubbles and weeds collected should be removed.

Spacing :—The yield of maize depends upon the number of cobs produced per plant. This, in its turn depends upon the richness of the soil, the character of the season, the time of planting and aftercare in its cultivation. Most economic yield may be expected when a single maize plant has about 4 square feet area for feeding, as its roots spread laterly about 2 feet all around the plant. In order to get the most economical yield per acre, each seed should be sown 24″ x 18″ on rich soil, while on poor soils and in cases of late sowing, the spacing may vary from 1 to 2 square feet.

Seed: —The seed for sowing must be sound and of good vitality. It should be from the cobs of the previous year's harvest, pure of extraction and true to type as well as free from moulds etc. The grains from the top as well as the lower most part of the cobs are not considered to be good for sowing and hence the grains from the middle may be used for that purpose. The importance of selection of seed is well known and has been emphasised all over the world by the various breeders, special attention, therefore, in this respect is essential.

Time of planting :—Maize being a field crop is generally sown after the break of regular monsoon in Adra Nakshatra i.e. by the 4th week of June, when grown for grain purposes so as to mature and ripen when the rainy season is over. But when it is grown for green cobs, it is planted by the 1st week of June in Mirag Nakshatra under irrigation. The normal planting season however extends from 7th of June to st of July. A crop planted early with irrigation generally yields a better harvest than one planted later with rains. Green cobs from an early sown crop are always available for the market much earliar and invariably fetch a better price as cobs from the general crop are not ready for the market till much later.

Planting of maize seed :—These are usually planted 2 inches deep, the range of depth varying to a considerable extent with different soils, claimatic conditions and time of planting. It is however advisiable to plant 2″ deep to insure a good germination and stand. The rate of planting also varies with the size of the seed, its vitality, variety sown, time and method of sowing and the purpose for which the crop is grown, for grain or for fodder. The number of cobs on each stalk as well as the size of the cobs are mostly regulated by thick or thin sowing. 4 square feet for each plant on a rich soil containing humus will give healthy vigrous plants which will produce well filled cobs from which a heavier yield can be obtained than from a crop sown at a higher seed rate. As a general rule, planting is usually done thickly on a poor soil, and more thinly on a rich soil. Usually a crop of maize contains 14,520 plants per acre allowing 3 square feet area for each plant (43,560 square feet ÷ 3), whilet here are 2,500 sound grains in one pound of maize seed, so that 6lbs of seed will be theoretically required to plant one acre of land, but the germinating capacity of maize seed is low hence seed rate varies from 3 to 12 lbs per acre, when sown for grain and 12 to 20 lbs when sown for fodder.

Method of planting:—The sowing of maize is usually done by the cultivator in rows 18″ apart by means of a bakher to which a Sarta (or bamboo tube) is attached behind. An expert cooly feeds the drill with regularity and precision through the tubes. On the Nagpur Farm, however, it is sown with a three coulter drill in rows 24" apart. Sometimes the seeds are dibbled in these rows drawn 24" apart, at an interval of 18". Germination starts on the third or the fourth day and the seedlings come up above the ground on the 6th day. If they do not come up within a week the gaps may be filled up by dibbling.

Irrigation :—A maize plant thrives only when there is sufficient moisture in the soil during its growing period. Hence when the crop is sown early in June before the break of regular monsoon, the first care required is to supply sufficient moisture by irrigations once in 5 days till the rains start in right earnest. After the commencement of the regular monsoon, however, the crop needs no irrigation provided the rains are regular and well distributed during the whole of its growing period, but when there are long spells for more than 10 days of dry weather the crop is irrigated once in 7 days.

Weeding, thinning and interculture: —

After the seedlings are about 12 inches high, the weeds should be taken out and the extra plants uprooted keeping only one healthy plant at each place 18" apart, in the row. If however, there are gaps of more than 18" distance they should be filled, up by transplanting the uprooted plants. The maize crop in its early stages grows rather slowly when compared with its after growth, hence, it is very essential to weed the crop thoroughly when it is young. One hand weeding followed by two or three hoeings would keep the field free from weeds in the early stages of growth. Afterwards, the quick growing plants cover the area and smother the weeds. It is better to earth up the plants at the time of final hoeing which prevents lodging during high winds. The adventitious roots which enter into the soil later on, help in absorbing nourishment from the soil and also prevent the lodging of the tall plants by giving additional support which is necessary when the maize crop is in full bearing.

To dressing:—When the plants are about 18 inches in hieght and the filed thoroughly cleaned of weeds and the crop thinned out properly, mixture of 30 pounds of ammonium sulphate and 30 pounds of nitrate of soda is applied in between the rows and the crop is hoed 4" deep, so that the manure applied is shifted towards the base of the plant and covered by the earth moved by the hoeing implement. The nitrogen contained in the nitrate of soda will be available to the plant at once while that of ammonium sulphate will be made available after a week or so.

Watching:—A standing crop of maize is often damaged by pigs, monkeys, jackals, birds, squirrals etc., while green cobs are often removed by pilfering. As a rule, therefore, watching of the crop from the time it begins to flower and throw out spikes to the time of harvest is very essential.

Yield of green cobs per acre:—When the maize crop is to be disposed off green, it is harvested much earlier i.e., as soon as the grains are in the milky stage. In good yielding varieties, the average number of cobs per plant is generally found to be one. Thus out of 14,520 plants per acre, taking 80% of this as being fully bearing, there would be $\frac{14{,}520 \times 80}{100} = 116{,}16$ = or roughly 11,500 cobs per acre. These are sold usually at the rate of 10/- to 15/- rupees per 1,000. Taking the average value of 11,500 cobs at Rs. 12/- per 1000 cobs, it will yeild 11,500 × 12/100 = 138/- per acre.

Harvesting of crop for grain:— When the crop is grown for grains it is better to select the cobs for seed for next year's sowing. To maintain the standards of high yeild, not only the improved cultural methods are necessary, but in addition, the seed for sowing must be selected from robust and healthy plants of the improved types bearing two good cobs. This selection, therefore, must be done before harvesting the standing crop in the fields. The principal points to be taken into consideration for the selection of cobs are as follows:—

(*i*) The plants to be selected must be healthy and strong bearing two good sized cobs.

(*ii*) The position of cobs on the plants should roughly be 2.5 ft. from the ground.

(*iii*) The cobs selected should be long, thick and heavy, not tapering but cylinderical in shape.

(*iv*) The rows in the selected cobs should be straight and the grains well developed and large, of bright colour and true to type.

(*v*) The setting of grains on the cobs should be uniform and nearly up to the top.

(*vi*) The cobs should be quite free from any diseases.

(*vii*) The selected cobs should be true to the desired type. Thus selected, these plants are to be marked down by tying a piece of string so as to be harvested only when dead ripe and gathered separately. When thoroughly dried, the cobs are either stored in dry earthen pots or hung up on a piece of bamboo tied to the roof of the kitchen room where the smoke prevents them from being attacked by insects. They are allowed to remain there till required for the next year's sowing. Loose grains are more susceptible to the attack of weevils than grains on a whole cob. It is therefore always better to store the cobs in dry and airy places.

Harvesting:—The crop for grain purposes is harvested when it shows distinct signs of drying with the cob sheaths completely dried and the grains fully matured. The harvesting is done by pulling out the cobs from the plants and the stalks are afterwards cut and fed to cattle or dried and stored. The cobs, however, are spread out in the sun after removing the husk for further drying for about a week or so. Each day they are spread out in the morning and collected into a heap in the evening till they are properly dry.

Yield:—The yield of a maize crop depends much upon the variety, soil and climatic conditions, the time of sowing, cultural operations and other factors, and varies from 500 to 3,000 lbs per acre. The late varieties as a rule yield higher, while the early ones yield less. As usual, a better out-turn is obtained from a well drained rich soil than from a poor soil. Early sowings in June give better results than those sown later. The number of rows in each cob varies from 10 to 18, while the number of seeds in each row varies from 10 to 40. Taking the 11,500 plants bearing one cob each, add each cob having 12 row on an average with 20 grains in each row, there will be 11,500 × 12 × 20 = 27,60000 = 1104 lbs per acre. Ordinarily the out-turn per acre in the well managed ones comes to 1,000 lbs per acre. Under the improved conditions of cultivation, proper manuring etc., it is possible to increase the out-turn to 2,000 lbs per acre, which is the average out-turn per acre in America. The average yield of maize in some of the important maize growing countries are given below:—

Hungry—1680, U. S. A.—1500, Italy—1450, Austria—1260 Argentina—1140, France—1080, Russia—1020, India—986, U.P.—800, Bihar or Orissa 908, Bombay— 1200, C. P.— 600, Punjab—1,000 pounds per acre.

Out put of straw from the grain crop:—The stalks of the maize crop from which the green cobs in milky condition have been removed, form a nutritious fodder when fed either green or dry. The fully natured dry stalks are less nutritious, as all the important food material is transferred to the grain. The cultivators generally do not use it as fodder for cows and bullocks, but when there is scarcity of fodder, the dry stalks are chopped into small prieces 1—2 inches long and fed to milch buffaloes. The average yield of straw of a maize crop when sown for grain is one ton per acre while heavier yields about 3 to 4 tons have been obtained from crops sown in gardens for green cobs.

Cultivation for fodder.

In some districts of India mostly in the Deccan, maize is grown for fodder either under irrigation or in the field after the commencement of rains. After preparing the seed bed 20 to 30 lbs of maize seeds are drilled in 12 inches apart. Only one weeding is given and 2 hoeings. When the seeds are in the glazed condition, the green crop is cut after 75 days from sowing and is either dried for fodder or fed green by cutting out daily as much as is required or the whole thing is turned into a silage. The outturn per acre amounts to 4 tons—6 tons of green fodder under careful cultivation. In America maize is the only crop out of which silage is made and it yields about 16 tons of green succulent fodder containg 70% of water when harvested for making silage.

As a producer of fodder, maize probably stands only second to juar in amongst the fodder crops of the world and it may even be doubted whether it is not in many cases considerably superior. It produces almost as much good fodder per acre just as Juar does but it requires liberal manuring. It can grow over a larger range of country than juar and may be fed at any stage of its growth far more safely than is the case with juar. Maize is probably the best emergency fodder crop to grow whenever there is scarcity of fodder as it grows very quickly. Also it reqires comparatively litte water, considering the amout of fodder it yields and it can be cut at any stage and fed to the live stock without danger. The maximum yield and digestiblity however, can only be obtained when the grain is in the dough stage. The crop is usually ready to be cut in about two months time but in cold weather the time taken for its maximum growth is longer than in summer.

Utilization:—Maize is usually cut and fed green, to the live stock direct, when the crop is required for fodder, it is grown very thickly, otherwise, the lower part of the stalks becomes very coarse, and the lower leaves decidedly fibrous. If grown thickly, this isvery good.

The digestibility of maize fodder does not materialiy change until the dough stage is reached. According to an American test carried out on sheep, the following percentage of digestibility ~~was~~ was obtained from immature fodder and fodder at the dough stage:—

		Proteids.	Fat.	Nitrogen free extract.	Fibre
Percentage digested.	Immature fodder	47.4	45.9	57.6	67.9
	Fodder at Daugh stage	36.6	66.1	60.6	50.7

The above figures indicate that as the crop gradually ripens its digestiability decreases in so far as its proteids and fibres are concerned. The cattle however, digest all the constituents rather better than the sheep. In case of juar which is the best fodder the protieds, the fibres and the nitrogen free extracts are more easily digestible than in mature maize.

When the maize crop is allowed to ripen and the cobs with grains on are taken out its fodder is poor to be fed to cattle unless mixed with some more nutritious fodder such as that of legume. Maize has not been made into hay, that is to say, cut in dough stage, dried in the field and stocked. Its silage is a very satisfactory feed. The crop for silage purposes should be cut when the grain is in the dough stage and immediately taken to cut up for silo. It reaches its maximum food value when it is nearly matured i.e. when the cobs are formed and well filled with grain. At this stage it is the best for silage purposes.

* * *

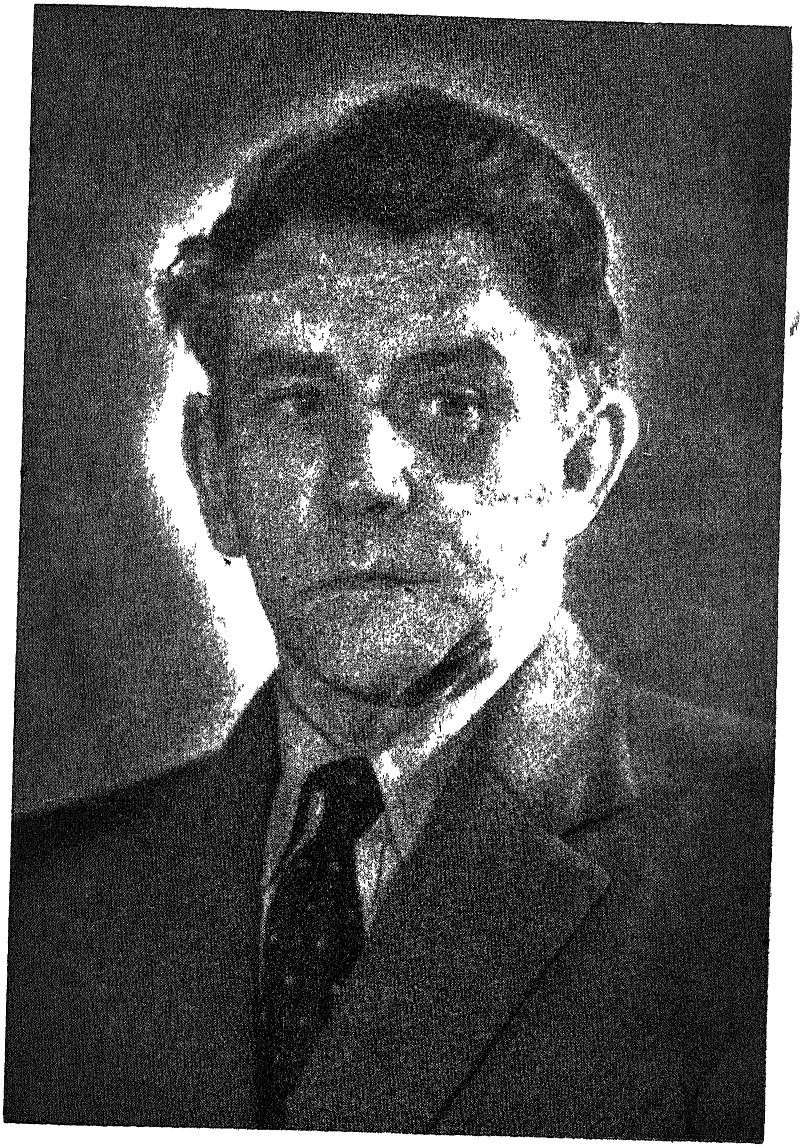
COST OF CULTIVATION OF MAIZE.

Particulars	Field crop		Garden crops green cob		Fodder under irrigation	
1. Cost of manure @ -/12/- per Cart ...	...	...	16 Cart loads	12 0 0		12 0 0
2. Carting charges 2 pairs+2 men+ -/10/- -/5/- +2 F. coolies Carts ... -/3/- -/2/- ...	...	...		2 6 0		2 6 0
3. Spreading charges coolies @ -/3/- ...	...	...	4 Female coolies	12 0	with bakher	0 15 0
4. Ploughing with iron plough 2½ days plough -/2/- per day	...	...	5 Pairs+7½ men	6 1 6	...	...
5. Bakherings	2	1 15 0	2 Bakherings	1 15 0	...	1 15 0
6. Picking stubbles	2 Coolies	0 6 0	4 Coolies	0 12 0	...	0 12 0
7. Final bakhering before sowing ...	1	1 4 6	1	1 4 6	...	1 4 6
8. Cost of seed @ -/1/- per pound ...	25	1 9 0	16 lbs	1 0 0	30 lbs	1 14 0
9. Sowing charges	13″ apart	0 9 6	2 ft. a part	0 5 3	13″ apart	0 9 6
10. Weeding and thinning	6 Coolies	1 2 0	8 Coolies	1 8 0	8 coolies	1 8 0
11. Hoeings	3 Hoeings	1 9 6	2 Hoeings	1 4 6	2 hoeings	1 4 6
12. Cost of manure Amonium Sulphate & Nitrate of Soda	...	...	56 lbs	3 0 0	one maund	5 8 0
13. Applying charges			1 Cooly	0 3 0	one Cooly	0 3 0
14. Irrigation charges @ 3/- per time ...	...	...	3 Times	9 0 0	15 irrigations	15 0 0
15. Watching (proportionate) on month@ 7/8/	...	...	...	2 8 0	...	...
16. Land Revenue and taxes	...	1 8 0	...	2 11 0	...	2 11 0
17. Harvesting coolies @ -/3/- per day ...	6 Coolies	1 2 0	8 Coolies	1 8 0	12 coolies	2 4 0
18. Drying the seed	1 Cooly	0 5 0	...	...	...	...
19. Shelling with stick	2 Men	0 10 0	...	...	...	...
20. Storing	1 Man	0 5 0	...	...	...	...
	(1)	12 5 6	(2)	48 2 9	(3)	50 2 6
(1) The value of 600 lbs of grain @ 30 lbs per rupee		20 0 0				
(2) The value of green cobs (11,500) @ 12 per 1000 green cobs				138 0 0		
(3) The value of 10 tons of green fodder @ 10/- per ton of fodder						100 0 0
Net profit per acre ...		7 10 6		89 13 3		49 13 6
Plus fodder @ 4 per ton		4 0 0		25 0 0		...
		11 10 6		104 13 3		49 13 6

OUR CHIEF GUEST

SIR GEOFFREY POWNALL BURTON
M.A. (OXON), K.C.I.E., I.C.S.

ADVISER TO H E. THE GOVERNOR, C P. & BR.



R. H. HILL. Esq. M. A., I. A. S.,

DIRECTOR OF AGRICULTURE C P & BR.

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Editorial

THE VICEREGAL VISIT

Sunday the 27th February 1944 was a Red-letter-day in the history of the College Farm. His Excellency the Viceroy Lord Wavell visited the farm in the morning. He was met at the Farm Office by Mr. Hill our Director, who was presented by His Excellency the Governor, Sir Henry Twynam, who accompanied Lord Wavell. Mr. Hill then presented Mr. Churchill, the Principal of the College, who conducted the party round the Farm. It was explained to His Excellency that his visit fell between the seasons and that at the time, there was not very much interesting work going on.

The threshing floor had, however been prepared, and the threshing of late Juar was going on and Tur was being prepared for threshing. His Excellency expressed surprise at the method of threshing under bullocks' feet and it was explained that in view of the number of sections using farm land and the number of trials and experiments, there was no crop sufficiently large to warrant the use of a threshing machine. Lord Wavell noted that the old biblical rule was not carried out on the threshing floor in regard to the bullcoks. This was a reference to the old injunction, "Thou shalt not muzzle the ox that treadeth out the corn", in the old Jewish Code, appearing in the Christian Bible. The farm bullocks, however, may suffer from hard work. They certainly do not suffer from a shortage of food.

His Excellency was most interested in the Gaolao trotting bullocks, and one pair was specially yoked for him to see it in action.

The party then went to the College Dairy Farm at Lendra where His Excellency again showed his interest in livestock. He admired the new Montgomery Bull and was very intererted in the pedigrees of many of the cows, with their varying degrees of Ayreshire and Sahiwal elements.

A note on the visit of this distingushed soldier-Viceroy would not be complete, without mentioning a discussion, which took place during the inspection of some of the implements on the "Home" Farm. It was explained to Lord Wavell that according to the latest teaching, deep ploughing was not encouraged now-a-days. All students of agriculture will realize the nature of the times we are passing through, when such a revolutionary teaching is accepted or partially accepted, so calmly.

At the Agricultural Research Institute.

H. E. the Viceroy and party then motored to the Agricultural Research Institute. At the South entrance H. E. the Governor presented to H. E. the Viceroy, Mr. R. H. Hill, Director of Agriculture, who then presented Rao Bahadur Dr. D. V. Bal, Agricultural Chemist and Senior Research Officer. The party then proceeded to the Chemical Laboratory where Rao Bahadur Dr. D. V. Bal explained some of the important items of research undertaken by him. The Section is engaged in research on soils, fertilizers, chemistry of plants and plant products, animal nutrition and dairy chemistry and in imparting instruction to the students of the Agriculture College. The results obtained by the Section, which were suitably exhibited, related to the mechanical and chemical composition of typical soils of the Central Provinces and Berar, decomposition of oil cakes and green manures in soils, comparative nitrogen recuperative values of legumes and their importance in crop rotations, composition of samples of char-coal with a view to finding their suitability for the gas-producer, oil contents of groundnuts, nutritive values of C. P. fodders and feeding stuffs, effects of different feeding stuffs on the carotene content of milk, effects of manurial treatments on yield and the mineral contents of pasture grass etc. Some of the methods of improving agriculture aud livestock which were also demonstrated caused interest; chief of them being, simple methods of preparing compost from field wastes and bone-manure from raw bones, which on use may increase the yield by 100%, the method of inoculating seed with specific nodule bacteria for ensuring the satisfactory growth of leguminous crops, the method of manufacturing bright-coloured gur by boiling the juice after liming and filtering it through activated rice-husk char-coal (using sodium hydrosulphide if necessary), balanced maintenance rations for cattle, preparing mineral brick-licks with a view to correcting mineral deficiencies in cattle diets etc. After inspecting the B. Sc. (Agr.) students' laboratory the party entered the Oil Seeds and Rice Research Laboratory which is in charge of Mr. B. B. Dave. The Oil Seed section is conducting researches with a view to evolving varieties which would give better yields, have a higher oil-content and which will be disease-resistant. The varieties under trial were kept on view. Twelve new strains of paddy obtained by selection and hydridization figured prominently. Mr. Dave pointed out the great possibilities of increasing paddy production in the province when the area under improved varieties is gradually increased, under the new scheme of the C. P. Government. He also added that increased outturns would be obtained by the application of groundnut cake and compost manures to paddy.

The Second Economic Botanist's Section in charge of Dr. G. S. Bhatia is, besides teaching, engaged in conducting research of varied nature *e.g.* multiplication of seeds of juar, pulses, lesser millets, rabi juar, soybeans grasses, sannhemp etc. Dr. Bhatia pointed out the results of yield experiments of these crops and showed their most successful varieties *e.g.* Pulses-gram E. B. 28, 62, 352; Tur - White seeded and early maturing E. B. 3 and E. B. 38; Soybeans :—E. B. 53 and 59; and 9 selected species of grasses. Part of the notable work of the Section conducted under Dr. Bhatia's gudiance, which won special attention owing to its topical importance is the success obtained in the raising of ***Cryptostegia Grandiflora***, an indigenous rubber plant, from its cuttings.

After visiting the Veterinary Research Laboratory stationed in the same building the party moved to the Mycology Section where Dr. R. P. Asthana, Mycologist, explained the special measures recommended in protecting food, vegetable and fruit crops *e.g.* wheat, juar, rice, potato, citrus etc. from the diseases like rust, smut which damage the crops. Dr. R. P. Asthana outlined the sceintific investigations which aim at finding out simple and economic remedies to combat the same and demonstrated the methods recommended by him.

The Economic Botanist for Cotton, Mr. S. S. Pande whose section was next visited showed varieties of Cotton evolved by the Section. Verum 434, Buri 107, H420 were pointed out to be the strains of long staple Cotton, much in demand owing to their high ginning percentage and suitability to natural conditions obtained in the cotton areas of the province. Results relating to varietial, rotational, manuring and cultural experiments were explained. Samples of the varieties of ground nut evolved by the section *e. g.* A. K. 10 and A. K. 12-24 were exhibited.

* * *

RAO BAHADUR Dr. D. V. BAL—An appreciation.

RAO BAHADUR D. V. BAL,
M.SC. (Agr.) HONS., Ph.D., A.I.C.,
F.C.S. (London).

THE election of Rao Bahadur Dr. D. V. Bal to the Presidentship of the Agricultural Section of the Indian Science Congress, held at Delhi this year, is a fitting honour bestowed on one who has devoted himself heart and soul to the cause of Indian agriculture. The honour is noteworthy, coming as it does, after several years, to this province, for the second time, the previous recipient being Dr. D. Clouston in 1921.

After a brilliant career at the College of Agriculture, Nagpur, he joined the C. P. Agricultural Department in 1913. Later, he proceeded to undergo post-graduate training at the Imperial Agricultural Research Institute, Pusa and the Rothamsted Experimental Station, Harpenden, England. His flair for research marked him out for successive promotions in the Department. In 1920 he was raised to the C. P. Agricultural Service Class II and in 1931 to Class I as Agricultural Chemist. He also held, in addition, from time to time, the posts of the Principal, College of Agriculture, Nagpur, Deputy Director of Agriculture and Mycologist. He worked on the Board of Agriculture in India, for four years during the period 1935-41 and has been a member of the Soil Science and the Animal Nutrition Committees of the Imperial Council of Agricultural Research. He also represented the province at the International Soil Science Congress held at Oxford in 1935. Besides, he holds prominent offices on various scientific bodies in India and the International Societies of Soil Science. He has the signal honour of being the first recipient of the M. Sc. (Agr.) Hons. and Ph. D. degrees since their inception under the Faculty of Agriculture at the Nagpur University.

As an agricultural chemist he occupies a leading position amongst the Indian Scientists, owing, in the main, to his valuable researches which abound in the annals of foreign and Indian scientific journals and test books.

In the sphere of education, the C. P. High School Education Board, the Nagpur University and the D. Laxminaryan Technological Institute, have benefited largely, due to his keen interest, energy and guidance. What the Nagpur University owes to his services is apty expressed by Lt. Col. Dr. T. J. Kedar, Vice-Chancellor, in his speech at the Convocation in December last—" I am proud to make a special reference to Rao Bahadur Dr. D. V. Bal who spared no pains to make my regime succssful. In fact he was a tower of strength to me in financial matters and I feel bound to record my grateful tribute to his great sagacity, unerring precision and unsparing industry. "

In recognition of his valuable services the titles of Rao Saheb and Rao Bahadur were conferred on him in 1936 and 1939 respectively, and he was also awarded the Jubilee and Coronation medals.

The Rao Bahadur has endeared himself to all alike by his genial temperament and earnestness. He is ever at the service of those, who, with zeal and industry offer themselves to follow his own path of toil and sweat and cherish the worthy ideals set by him.

* * *

Some aspects of the present and Post-war Food Production in India.

Presidential address delivered by Rao Bahadur Dr. D. V. BAL, M.Sc. (Agr.), Ph.D., A.I.C., F.C.S., President, Section of Agricultural Sciences, at the 31st Session of the Indian Science Congress, 1944.

IT is with great pleasure I welcome you to the Section of Agricultural Sciences of the 31st Session of the Indian Science Congress. Further, I wish to express may heartfelt gratitude to my fellow workers and friends for having done me the signal honour of electing me the President of this Section, and I regard it as an appreciation of my humble services to the cause of agriculture for the last 30 years. That does not mean that I am not conscious of my shortcomings nor I am oblivious of the fact that I have to maintain the traditions set by my illustrious predecessors. It is in the spirit of service to Science that I have accepted the responsibility and I crave your indulgence.

The influence of the present world-wide war on the production and supply of food in our country having assumed a very serious importance at the present moment, this subject is naturally uppermost in my mind and I have therefore decided to briefly record some of my views in this connection.

PRE-WAR (1935) PRODUCTION AND SUPPLY OF FOOD IN INDIA

According to the calculations based on the calorific requirements of the population and on the capacity of the area under cultivation in India to meet these, it has been shown by Mukerjee[17] that during the year 1935, nearly 48 millions of the population representing average men had to go without food, on the assumption that the rest of the population, which was about 329 millions, obtained their basic minimum ration.

On a study of the figures of imports of food grains from Burma and foreign countries during recent years, Gyan Chand[15] has shown that India has of late become, to an increasing extent, a food-importing country, the imports amounting to about 2 to 2·6 million tons, and India's own food supply has thus fallen short of her requirements. He further states that although the increasing volume of imports of food grains may be taken as a sign of increasing commercialization of the economic life of the country, the fact remains that in spite of India being predominantly agricultural, she is now importing increasing quantities of food grains, and the situation briefly explained in his own words is, "India is a country of teeming millions and they are wretched and racked by hunger and despair. Their position has to be retrieved if they are not to be driven from blank despair to maddening desperation."

Prominent Indian politicians also often mention that there are millions of starving half-clad people in India who have to remain content with either half or one meal a day. It will thus be seen that on this problem, unanimity of opinion exists among the different sections of the thinking public.[23]

PRESENT-DAY POSITION

According to the 1939-40 figures,[16] area under cereal crops like rice, wheat, maize, *juar* and other millets in British India, is about 146·6 million acres and if it is presumed that the production of crop is normal as per standard out-turns fixed for the various crops, we should expect a gross out-turn of consumable produce of approximately 55·8 million tons. Allowing about 2·6 million tons of this produce for seed purposes, the quantity of cereal food grains available for human consumption comes to 53·2 million tons. Figures relating to British India only have been taken, as those relating to the Indian States were not available to the full extent.

Taking the latest census figures, the population of British India in terms of average adult individuals (two children under 12 years of age being roughly considered to be equal to one average adult individual for this purpose) is about 236·6 millions. A basic minimum ration for an adult individual, according to Aykroyd[2], should provide 15 ozs. of cereals, 3 ozs. legumes, 2 ozs. fats, in addition to 8 ozs. of milk and 12 ozs. of vegetales and fruits, giving a total energy value of 2600 calories per day.

It is a well-known fact that a very considerable proportion of our population never takes any milk at all and the intake of oils as well as meat, per head, per day is also negligible, showing thereby that the required minimum calorific value must therefore be derived from the staple cereal food grains. Calorific value of cereals as a whole may be taken to be equal to 350 calories per 100 grams. Average requirements in respect of cereal food grains, per head, per day, would thus come to 1½ lbs. on the assumption that about 275 calories are derived from oils, pulses, etc., as shown by diet surveys[3,10] and 1¾ lbs. if the total calorific requirements are to be derived chiefly from cereals only. On this basis, total quantity of cereal food grains required will therefore amount to 57·8 to 67·5 million tons which is higher by 4·6 or 14·3 million tons respectively than what the land can normally be expected to produce under existing systems of crop production; in other words, the present production from the existing area under cereal food crops will have to be raised by 8·6 to 26·8% in order to meet the minimum food requirements of the population. Taking the present population of India including Indian States at 389 millions or 311 millions in terms of average men, the position in respect of food production to-day would thus appear to be worse than that described by Mukerjee, Gyan Chand and others some 6 years ago, as the then estimated total population was about 377 millions which when converted into average men was equal to only 301·6 millions, and as is well known, the increase in the area under food crops and normal yields has not been proportionate to this increase in propulation.

When we take into consideration the fact that, factors like seasonal fluctuations, wastage during processing, transit and storage, quantity of food grains consumed by poultry, agricultural and other animals, etc., have not been accounted for in the above calculations, the deficiency in respect of food grains even in normal times must be more acute than what has been shown, and it would be still worse in years of famine as there would be no appreciable surplus produce left over annually to build up any reserves as an insurance against famines.

The argument advanced against the position of import of food grains is that the increasing volume of imports is a sign of increasing commercialization of the economic life of the country. In ordinary peace times we may have been able to import foodstuffs in exchange for non-food or commercial crops, but this reliance on imported food grains has made the position of India precarious in the present abnormal state of the world. The present appalling conditions in respect of food scarcity in certain provinces should prove a good eye-opener and bring home not only the immediate but an everlasting need to adjust our food production in such a way as to make India not only self-sufficient but also to enable her to provide for an adequate surplus as a margin of safety in abnormal years, which quantity can be available for export in years of normal production.

That a country like India, which is predominantly agricultural should be dependent on imports from other countries to meet the food requirements of her population is, to say the least, very unsatisfactory. We have enough land and our first and foremost aim of crop production should be to ensure, above all, the minimum requirements in respect of food and clothing for every individual citizen.

SUGGESTIONS TO ENSURE IMMEDIATE MAXIMUM FOOD PRODUCTION

It will thus be evident that leaving aside questions like birth control and other measures for checking the growth of population, our immediate need is to increase food production to the maximum extent possible, apart from the economic factors governing crop production. Maximum capacity of soils of different regions or tracts in regard to crop production depends on various factors out of which climate, soil type, soil fertility, quality of the seed and incidence of disease may be considered to be of outstanding importance. It therefore naturally follows that in order to secure maximum out-turns of crops, these various factors must either be most favourable in relation to the general crop production of various regions or tracts or, in the alternative, cropping systems should be so adjusted as to derive maximum benefit from the existing factors. This raises a number of issues which, though it is not possible to discuss at length, are briefly dealt with below.

Climate.—Although we cannot exercise any control over the climate, deficiency of soil moisture can, to some extent, be made good by provision of irrigation facilities and a scheme should be drawn for this purpose to encourage construction of wells in areas possessing fairly shallow water table. Soil moisture can also be controlled by the provision of adequate conservation or drainage, and various regions or tracts should, therefore, be surveyed for this purpose and comprehensive schemes for the construction of bunds and drains should be drawn up. The State should play its part in putting these schemes into operation and sufficient funds should be made available to the cultivators at low rates of interest, together with a provision for adequate subsidies and easy instalments for the repayment of loans.

Soil types.—The practice of utilizing apparently unsuitable lands for a particular crop is in many intances responsible for the low yields in certain localities. It is, therefore, essential to see that only such crops as are suitable for particular soil types, as well as for soils according to their position factor, are grown in the various tracts. Special village surveys for this purpose would be necessary. Lands, which are considered to be below standard for production of arable crops, should de diverted to pasture or tree growth and steps should be taken to improve the yield and quality of the herbage and trees to be grown thereon as well as those grown on the existing areas.

Soil Fertility.—Soil fertility is dependent principally on (*a*) appropriate physical condition of the soil and (*b*) presence of adequate quantities of nutrient substances required for crop growth. Optimum physical condition of the soil depends upon the presence of right proportions of various mechanical constituents like, clay, silt and sand, and in addition, an adequate proportion of organic matter and lime. Data regarding analyses of soils and yields of crops from various manurial experiments dealt with in detail elsewhere [1, 6, 7, 13 14, 21, & 22], clearly show that Indian soils are generally deficient in organic matter and nitrogen, and have now reached a stationary state of fertility at a low yield level, as a result of cultivation over many centuries, without adequate returns of organic matter and phosphate, and due to the lack of proper soil management in certain important directions. Judging the results of various manurial experiments it can be stated without any fear of contradiction, that applications of moderate quantities of nitrogen i.e. 15 to 25 lbs. per acre, as farmyard manure, oil-cakes or artifical fertilisers, raise the yields of common field crops like cotton, rice, wheat and *jaur* to the extent of 25 to 33 per cent. In this connection it may also be mentioned that the full value of bulky organic manures is not returned in one year but their benefical residual effects on crop growth are visible over a number of years after the applications of manure are stopped.

It is, therefore, clear that special efforts must be made to improve the organic matter status of the soils. This can be achieved to a large extent by encouraging the preparation of composts from farm wastes by the cultivators and the preparation of composts from town refuse and night-soil in urban areas. As there is a considerable amount of prejudice amongst the cultivators against the use of composts prepared from night-soil and town refuse, the question of issuing this material free for a few years in the beginning and in addition of making small cash payments to the cultivators to partially cover the expenditure incurred in carting the manure from urban areas to their fields deserves very careful consideration.

With a view to maintaining the fertility of soils in general and their nitrogen content in particular, extensive cultivation of leguminous crops by developing suitable crop rotations and mixed cropping practices to meet the requirements of various regions or tracts is urgently required. The nitrogen recuperative power of some common legumes when grown singly and in rotation, with other crops has already been dealt with elsewhere.[5, 8, & 9]

According to the requirements laid down for a properly balanced diet, the minimum intake of pulses per adult individual per day must be 3 ozs. and the cereal protein legume protein ratio should be about 1·80. Total area under gram and other pulses in British India comes to 40·5 million acres which will normally yield 8·7 million tons of legumes. Out of this 0·7 million tons would be required for seed purposes leaving a balance of 8 million tons which would yield about 5·3 million tons of pulses. On the basis of the population in terms of average adult individuals (236·6 millions) the quantity of pulses available per head per day therefore comes to only 2·2 ozs. as against the minimum required quantity of 3 ozs. Diet surveys[10] curried out in the C. P. & Berar have also clearly shown that average intake of pulses per consumption unit per day is 2·1 to 2·5 ozs in the case of workers employed in cotton mills and manganese mines, and 2 ozs. in the case of cultivators.

In addition to the factor of minimum quantity of protein required per head per day, the biological value of the proteins, the importance of a small excess of proteins with a view to (i) accelerating the general vital processes of the body, and (ii) restoring the loss of proteins involved in the production of certain products like hair, nails etc. cannot be ignored. It will thus be seen that the amount of protein which is available for human consumption in India is definitely inadequate and apart from the soil renovating power of legumes, extensive cultivation of these crops is therefore of urgent and vital importance in order to improve the existing ill-balanced diet of the people.

Quality of the seed.—Without going into actual details of yield data of various experiments conducted in the past, it can be said that the existing yields of common field crops are in many cases capable of being increased by 10 to 20 per cent, if improved varieties of crops are grown in place of the local ones.[19] Selection of sound and healthy seed with good germinating capacity is also a very important factor which is intimately connected with the yields of crops. Efforts should, therefore, be made to immediately increase seed multiplication centres to meet the demands of the cultivators for improved seeds of various crops. The present strength of seed farms and plots is quite inadequate; and in order to meet the demand in full for improved seed, a net-work of Government and private seed farms together with suitable organisation for distribution of seed is of paramount importance.

Incidence of disease.—It is a well-established fact that crop yields are considerably affected from year to year due to the diseases caused by insects,[4] fungi and other casual organisms. It is therefore necessary to establish suitable agencies on a regional basis to deal with diseases of crops, as individual efforts by a few cultivators in this direction do not always meet with success, and elimination of a particnlar disease or a pest from the tract as a whole is absolutely essential to save the crop or crops of the locality.

Breaking up fallow land.—One of the methods suggested at present to increase the production of food crops in India is to break up fallow land. In this connection the position of the cattle *vis-a-vis* the human population must be very closely examined. Do we secure better production of food and fodder for the country as a whole by bringing new land under cultivation than by adequately manuring and cultivating the existing lands on an intensive scale and developing the fallow lands into pasture areas by adopting efficient methods of growing herbage and controlled system of grazing?

The backbone of Indian Agriculture is the cattle, as bullock power is the whole and sole motive power used for every agricultural operation in India. Any system of cropping which is likely to come into conflict with the interests of the cattle population must therefore be scrupulously avoided. The development of the live-stock industry has recently received a remarkable impetus due to the keen interest taken by Lord Linlithgow as Viceroy of India in problems connected with the improvement of cattle. Serious attempts are being made to effect an all round improvement in the cattle of the country by introducing better methods of breeding and as a corollary to this effort, improvement in the feeding of the cattle must inevitably occupy a prominent position, as it is generally recognised that improved breeding must always be accompanied by adequate feeding.

It is a well-known fact that the consumption of milk per capita per day in India is far below the minimum quantity prescribed for a balanced ration and the recent second edition of the report on the marketing of milk in India shows that the position to-day is even more distressing, as the consumption of milk per head during recent years has further dropped by about 12 per cent. Apart from the importance of cattle as a source of motive power in Indian Agriculture, the paramount importance of milk in the dietary of human beings cannot be over emphasised and any attempt calculated to improve the health of cattle by providing proper nutrition will therefore not only improve the general condition of the cartle, but in addition would render the greatest service to the population of India—whose daily diet is not only subnormal but ill-balanced—by augmenting the supply of milk.

Since the existing supplies of fodder and the area under pastures are inadequate and since it is not possible to check the practice of maintaining a large number of inefficient cattle which consume fodder which is essential for the better cattle, systems of cropping which are likely to increase the competition between the cultivators and their cattle must be adopted with very great caution and after a full consideration of the pros and cons of this important question. Fortunately for us, if better methods of cultivation and manuring are adopted, it is possible, as has been shown before, to increase the production of food crops by 25 to 33 per cent so as to adequately meet the food requirements of the population of the country, and it may not therefore be absolutely necessary to bring large areas of fallow land under the plough.

Storage facilities.—In certain cases like wheat, the damage due to weevil attack has been placed at 33 per cent, but taking the modest figure of loss for all crops at 2½ per cent,[18] nearly 1·3 million tons of the stored grain is annually being damaged in India as a result of insect attack. In addition to the various factors relating to the production of crops referred to above, the question of provision of adequate storage facilities to protect the produce against the attack of insects, rats and spoilage due to weather conditions must not therefore be ignored.

MAXIMUM *versus* ECONOMIC CROP PRODUCTION

In order to receive maximum out-turns of food crops as against the so-called commercial or cash crops, the State must however come forward to help the cultivators whenever required. If we only look to the economic aspects of crop production, as has been always done in the past, the persons to be benefited by this policy are mostly big land-holders, merchants and middlemen who are able to export the produce at profitable rates and meet their requirements by purchasing either indigenous or imported raw and processed foodstuffs at such rates which the average cultivators and labourers cannot possibly afford to pay. In view of the fact that it is obligatory on the part of the State to ensure minimum requirements in respect of food and clothing for every individual citizen, there is therefore no reason why a portion of the increaing industrial and commercial income which is ultimately derived largely as a result of the produce of the land should not be utilised in giving relief in the form of subsidies to the cultivators, should the business of crop production *vis-a-vis* industrial manufacture of finished articles becomes uneconomic or unremunerative. Our soils which have reached a stable minimum fertility level, are capable of yielding increased out-turns to the extent of 25 to 33 per cent, if properly manured and cultivated, and what is wanted therefore is a definite incentive to the cultivators to make the business of production of food crops, if not remunerative, at least not unprofitable. As the average calorific value of the daily diet per head in the case of factory workers and agriculteral labourers is only 2,100 as against the minimum requirement of 2,600, production of sufficient food in the country will not only improve the efficiency of crop production but also industrial manufacture by increasing the efficiency of labour. In this connection it will not be out of place to quote the examples of stabilisation of sugar production from sugarcane and beet in India and England respectively. Had the production of sugar not been subsidised or protected by adequate tariff by the State for a period of 15 years or more, the position of India and England today in respect of supplies of sugar would have been disastrous.

LONG-RANGE PROBLEMS RELATING TO FOOD PRODUCTION

In order to stabilise the production of various crops in general and food crops in particular, it is essential to consider the long-range problems and prepare a co-ordinated plan so as to make India a self-sufficient unit. In this connection it may be mentioned that some of the suggestions referred to above, which though can be put into effect immediately have also an important bearing on long-range planning of food production and in addition to those some other important long-range problems are briefly referred to below.

Experiments to determine maximum crop yields.—Properly planned experiments should be started to determine the maximum crop-yielding copacities of soils, *e.g.*, under a given set of soil and climatic conditions, and by adequate soil management and with maximum applications of mauures and fertilisers, what is the maximum crop-yield possible in a given region or locality ? An experiment recently conducted with sugarcane has shown that under conditions obtaining in India, yields as high as 100 tons of cane per acre—as against 15 to 25 tons today—can be obtained by adopting suitable methods of soil management and adequate manuring and irrigation. Experiments should, therefore, be conducted to obtain similar information in respect of other crops which would give a clue to the dominant factor or factors which affect crop yields. In designing these experiments particular attention should be paid to the organic matter and nitrogen status of the soils, and the standard experiments finally fixed should be simultaneously conducted for a certain specified period at various places under different sets of soil and climatic conditions.

Need for training a large number of young persons.—The need for fundamental research and continuity of research in agricultural science with particular reference to the day-to-day problems of the cultivators that are bound to arise in connection with the work of extension of improved methods through propaganda cannot be underestimated. Research work in agriculture to-day is as important as in any other subject. In order, therefore, to make a band of efficient workers available for both research and propaganda work, [20] steps should be taken to select and train the right type of promising young men of all ranks who can sympathetically appreciate the difficulties, requirements and aspirations of the cultivators.

Colonisation of new areas.—Thousands of men who have been recruited to the various branches of the Army Department can be utilised directly or indirectly for agricultural work after the war as follows:—

The demobilized personnel can either colonise certain selected areas and carry out individual or co-operative farming. Services of suitable men can be utilised in organised campaigns against diseases and pests of crops involving the use of elaborate and specialised types of machinery, insecticides and fungicides.

Their services can also be utilised in several ways in the village-uplift work, e.g., (1) running of day and night schools, (2) treatment of simple ailments of the cultivators and their cattle, (3) running small-scale work-shops for repairing agricultural implements, (4) improvement of village sanitation and (5) co-operative marketing of agricultural produce and of commodities required by the cultivators.

Similarly a large number of motor vehicles and tanks can after the war be suitably altered so as to make them fit for power work on the farms. This would not only ensure efficient cultivation of the existing cultivated areas but would facilitate the work of eradicating obnoxious weeds like *kans* (*Saccharum spontaneum*), bunding operations, stopping of erosion and breaking new land, all these factors being vitally important in securing maximum crop yields.

Prevention of fragmentation of holdings.—The problems arising out of the existing laws of inheritance which make fragmentation of holdings possible to such an extent as to make them uneconomic must be examined and adequate steps must be taken to prevent this practice. A suitable system of land tenure which will ensure a long-term and sustained interest to the cultivators who take lands on lease must be evolved. These two factors are vitally connected with the question of maximum yields that can be obtained from the cultivated soil and must therefore be carefully considered and a satisfactory solution evolved.

STABILISATION OF INCOMES OF AGRICULTURAL LABOURERS AND CULTIVATORS

A suitable system should be evolved by which basic wages could be assured to the agricultural labourers as is at present being done in the case of industrial workers by fixing their basic wages with the help of the index number of living and granting increased wages in proportion to the increased cost of living. As suggested above were necessary, incomes of the cultivators may also be subsidised to make the business of production of food crops, if not remunerative, at least not unprofitable.

CONCLUSION

To conclude, problems connected with the present and future food production in India have been broadly surveyed. It has been urged that we must harness together all the force at our disposal in order to increase the production of food in India, not only to meet her present requirements but to banish the problem of food deficiency for all times to come. The economic factor in the production of food crops must not deter us from the task of ensuring minimum requirements of food and clothing for India's teeming millions. As one of my predecessors has said, "increased production will help to banish famine and poverty from the land, and to bring us near the realisation of our hope, namely, to make India a garden, ringing with cheerful and contented life, with smiling fields and food in plenty."

The importance and urgency of this subject and the fact that economic and other factors must always occupy a subordinate place in relation to the question of sufficient food production cannot be better emphasised than to quote the following passage from the speech delivered by President Roosevelt to the delegates of the United Nations Conference on food and agriculture[12] "A sound world agricultural programme will depend upon world political security while that security will in turn be greatly strengthened if each country can be assured of the food it needs. Freedom from want and freedom from fear go hand in hand.'' It is needless to say that in so far as India is concerned, her food requirements can be best assured by increasing her food production capacity to the desired extent.

◆

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Food shortage solved in the Laboratory.

WITH a lump sum grant of $ 24,300 from the Rockefeller Foundation, the Massachussetts Institute of Technology conducted, during the last three years, some far reaching experiments on diet in their attempts "to pack the utmost of nutritional value into the minimum of food bulk and at the least cost."

Though numerous experiments, under the direction of Dr. Robert S. Harris, were carried out first with animals and then with human volunteers, the Institute developed formulæ which concentrated into a 1½ pound package of food all the daily requirements for one individual in proteins, calories, vitamins and minerals. With this concentrate as a base, the nutritional biochemists have been able to work out special food problems for several government agencies, including the Army, the Navy, the Merchant Marines and the Federal Surplus Commodities Corporation. Among the problems studied are rations for submarine crews, life-boat rations, and emergency rations for pilots and soldiers detached from the home base. Packaged food concentrates for dropping from air-craft have also been developed. Both Russian and British representatives tested the concentrated food, and certain shipments of it have been made to these countries. These concentrates, made of dried meat, cereals, milk powder, yeast, dried vegetables and seasoning, were also used by members of Admiral Byrd's polar expedition. Dr. Harris and his laboratory workers lived on this food, which cost only 6 cents a day, for weeks. They did not grow fat, but they remained in perfect health. This was made in the form of cereal flakes and tested by one dozen businessmen of Boston for 5 weeks with excellent results.

The above experiments are of enormous significance to India, where the population is increasing every year and agriculture is in a quandary. Does India, under these circumstances, desire to utilise the help of scientists to solve the food problem?

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The Cultivation of Grafted Ber (*Zizyphus jujube*)

(With Special Reference to village Bina, near Kamptee.)

By :— V. V. GOKHALE, B.SC. (Agr.)

TO an Indian, Ber fruit needs no introduction. It is the most widely grown fruit in India. There are several varieties of Ber, the most popular and delicious of which is the "Grafted or Pevandi Ber".

During the rule of the Bhonslas in Nagpur, this fruit had gained a great popularity. At present large quantities of this fruit come into the Nagpur market from the village Bina situated at a distance of 3 miles from Kamptee.

A short history of the cultivation of this fruit at Bina will not be out of place here. It is said that during the rule of Raja Raghoji Bhonsle the II, a Mohommedan cultivator of village Bina produced a grafted ber plant and presented its delicious fruit to the Raja. Being highly pleased the Raja gave him a gift of some land at Bina as "Inam", This Mohammedan cultivator was the originator of Grafted Ber in Bina. His survivors are still at Bina and own about 900 plants of Ber.

On learning the news of the cultivator's fortune every cultivator started the cultivation of this fruit and today one finds that all the wild ber plants at Bina and around are converted into grafted ones The following figures will show how the cultivation of this fruit has spread at and around Bina :—

Village			*Approx. No. of Grafted Ber plants.*
Bina	...	....	10,000.
Waregaon	....	....	2,000.
Waghoda	....	....	4,000 to 5,000.

Dorli	5,000 to 6,000.
Chicholi	6,000.
Dahegaon	4,000.
Korhadi	3,000.
Bhanegaon	5,000.
Itgaon	1,000.

Varieties :—There are several varieties of grafted Ber viz. Benares, Surat, Ahmadabad, Patna, Lucknow, Nagpur ect. All these are very delicious and have small sized seeds ; The Nagpur variety excels them all.

Cultivation :—Ber plant is produced by grafting. The stock is of common wild Ber and thus the plant is very hardy and can prosper in any soil without irrigation. Due to this fact it is not necessary to put any crop producing land under this cultivation.

For large scale planting, pits of 1 × 1 × 1½ are dug at a distance of 30′. One acre can accomodate about 48 plants. After digging the pits, they are left exposed for a few days so that the excavated soil gets weathered. Then, it is thoroughly mixed with F. Y. M. and refilled. Two seeds of selected wild Ber fruit are planted in each pit. During the rainy season the seedlings come up. No watering is required during winter, but in summer they should be irrigated thrice a month.

In about one year and a half the plants become ready for budding. During this time care must be taken to prevent these plants from being eaten by animals like Goats who are very fond of tender ber foliage.

In the month of April or May budding is performed on these plants. The buds sprout in about six weeks' time. When the new shoot attains a length of about three inches, the stock plant 3 inches above the bud should be cut off. No branches should be allowed to develop below the bud. During the rains the new shoot grows very vigorously. As soon as it attains a length of 9″ the top should be cut off to induce branching.

Grafted plant begins to give fruit from the second year ; but it is desirable to take the fruit from the third year in the case of new plants.

Some times there are large numbers of wild ber plants. These can be improved by budding as follows:—The trees should be cut off flush with the ground, and some trash should be burnt upon them. This produces very strong shoots. These can be budded in the following month of May. These plants have got an already established root system and can give fruit from the very first year.

Ber plant has got a very deep going tap-root and hence transplantation is not possible in this case. For this reason it becomes necessary to plant the stock plant in the permanent place and then graft the bud on it. In rare cases when the plants are required to be sent to other places, wild ber seeds are planted in earthern pots and then budded. Such plants can be transplanted. But many buds do not survive under the conditions in the pot and the percentage of failures in such cases is great. Ber grafting can also be performed by the process of "Inarching" but budding is the most common method.

Shield budding which is common in case of orange and rose is also adopted in this case. Budding should be done when the sky is cloudless and clear.

Pruning :-In cases of commercial plantations this is the most important operation. No plant will produce economically profitable amount of fruit unless it is pruned every year.

The best season for pruning is in the months of March and April. In these months the fruit season is just over and all the buds of the plant are in a dormant state. The flow of sap is also the least and hence least injury is done to plant when pruned during these months.

While pruning, all the branches below the thickness of about ½″ to ¾″ should be removed. The operation should be performed with a sharp pair of "Pruning Scissors", and the cuts should be clean.

During the next rainy season the plant puts forth vigorous branches and these bear abundant fruit. The fruit ripen in January and the fruits are all over by the end of February.

Manuring :- In fact this plant has got a very strong and deep root system and thus it can fetch its food material from a large area. Normally no manuring is required, but in the case of commercial plantations, 3 to 4 baskets of well rotted F. Y. M. should be given in the beginning of rains.

Diseases and Pests :- This plant is very hardy and can face all climatic changes. There are no diseases as such. There are however certain insect pests which cause considerable damage.

The first one is the larvae found inside the fruit. Some times this causes such a havoc that in certain parts the majority of fruits are attacked by these.

The second one is the "Inderbella" or the stem borer which damages the trunk by boring it.

Remedies :–It is rather difficult to control the first one but to some extent it can be checked by destroying the affected fruit. The soil under the trees should also be made loose and should be turned often during summer. This kills all the larvae in the dormant state. In some places a dose of about 4–5 lbs of common salt along with equal amount of coal-ash is administered at a distance of about 3–4 feet from the stem just before the beginning of rains.

In the case of the borer the holes are plugged after putting either petrol or Carbon-bi-sulphide or Chlorasol in them. The vapours kill the insects.

Income :- A healthy young plant produces about 1 to 1¼ maunds of fruit. The price fetched is on an average about 2 annas per seer. Thus every plant can fetch about 5 to 6 Rupees. So the income per acre amounts to Rs. 240 to Rs. 290 approximately. The cost of cultivation is very low as the planting is done on unproductive waste land and not much cost of care is required in cultivation, irrigation, etc. The only operations that require expenditure are pruning, watching and some manuring. Thus it will be seen that ber plants if planted in waste lands can give the cultivator a fairly good income.

◆

Note on an improved method of Farm-yard Manure preparation.

By: Dr. C. N. Acharya, M.Sc., Ph.D., F.I.C.

FARM-YARD manure is at present being prepared in most parts of this country by the farmer depositing his daily collection of dung and litter (what remains over and above the portion used as fuel), in big-sized round-shaped pits—big enough to take some 4 to 5 months' refuse altogether. The remaining 7 to 8 months' refuse is generally made into a heap on the site of the pit itself so as to rise to a height of 4 to 5 ft. above the surrounding ground level. The system is very elastic and involves the minimum amount of labour and supervision on the part of the farmer. The main defects of the system are:—(*a*) the rapidity with which the mass gets dry, since the daily collection of refuse is thrown haphazard over a wide area in the pit and, on account of the large surface exposed, the moisture loss is considerable, especially in the hot season; (*b*) on account of this rapid loss of moisture, subsequent decomposition is slow and irregular and the manure is generally not ready till the succeeding monsoon rains have again wetted the material and provided the necessary moisture, to complete the decomposition; (*c*) on account of the exposed nature of the mass, there is considerable loss of nitrogen, which involves almost the whole of the urine admixed with the litter and a good portion of the available nitrogen present in the dung; and (*d*) the quantity of manure obtained is often low, on account of the failure to utilize all the vegetable refuse that could be collected on the farm for purpose of farm-yard manure preparation.

In the attempts that have been made to increase the quantity of farmyard manure that could be prepared on the farm, open heaps have been recommended, which are given periodic turnings, along with moistening, till the material breaks down into a friable, humus-like powder, which is supposed to indicate its fitness for application as manure to land. The work carried out by the writer at Bangalore, Poona and other centres, has shown that the above method suffers from serious draw backs such as :—(*a*) the increased labour and watering charges involved, due to the turnings given and open nature of the heap, which render the method inapplicable in dry areas and prohibitive in cost to the Indian farmer in other areas; and (*b*) the heavy losses of organic matter and nitrogen that take place under the above conditions, especially if the manure heap is allowed to remain unused for a period of 6 to 9 months, as is usually the case over vast areas of the country.

The erratic and often unsatisfactory crop results that have been obtained in several parts of the country in experiments carried out to test the behaviour of farm-yard manure when applied to soils, are attributable to the defective methods of preparation noted above, which result in obtaining a manure of poor quality bereft of the readily available nitrogen fractions.

As a result of investigations carried out at Bangalore and at Poona in this direction, the writer has devised the following improved method of preparation of farmyard manure.

PREPARATION OF FARM-YARD MANURE IN TRENCHES.

It is preferable to carry out the manure preparation in trenches instead of in overground heaps, as the former are simpler in manipulation, involve less labour, conserve moisture better and are more efficient from the manurial point of view. Trenches, however, may not be found workable in areas, where the water—table is very high or during periods of heavy rainfall; in such cases, overground plastered heaps may be used.

1. *Trenches* :—The size of the trench should be sufficient to hold the collection of litter, dung, etc. obtained daily from the cattle shed over a period of 3 months. The suitable size would depend on the number of cattle maintained, the quantity of fodder that remains uneaten by cattle, the quantity of extra refuse available on the farm etc. Convenient dimensions for different farm sizes are as follows :—

Number of cattle maintained	Size of the Trench		
	Length	Breadth	Depth
2 to 4	20 feet	4 ft.—3 ft.	3 ft.—4 ft.
6 to 10	25 ft.	4½ ft.—3½ ft.	3 ft.—4 ft.
12 to 20	30 ft.	5 ft.—4 ft.	3½ ft.—4½ ft.
Above 20	30 ft.	6 ft.—5 ft.	3½ ft.—4½ ft.

Under 'Breadth' the first figure represents the breadth at the top of the trench; the second figure gives the breadth at the bottom of the trench, so that the sides of the trench are slightly sloping inwards. Under 'Depth', the first figure gives the depth at one end of the trench; the second figure gives the depth at the other end, the result being that the bottom of the trench has a slope of 1 foot from one end to the other; and rain water, if any, accumulates in the deeper end, and does not spoil the manure in the trench. The trench should, preferably, be situated quite near to the cattle-shed and on a higher elevation. The sides of the trench should be raised by a bund and made to slope away on all sides, so as to prevent rain water from getting in. It is not necessary to brick-line the trenches, unless the soil is very loose. The trenches should be situated adjacent to and parallel to the fence round the cattle shed, so as to leave the middle space free for other requirements.

2. *Cattle-Shed* :—The floor of the cattle-shed, should, preferably, be paved with stone. Where this is not possible, the floor should be hardened with *murum*. In all cases, the floor should be made to slope gently down to a drain running parallel to the length of the shed. The drain should be stone paved or brick-lined and should empty itself into a stone-paved or brick lined pit just outside the cattle shed. Cattle are usually tied up in the shed from evening to morning. The excretion of dung and urine during this period amounts to about 15—20 lbs. of dung and 10—15 lbs. of urine, depending on the size of the animals. The quantity of fodder left behind un-eaten in the morning, varies greatly from centre to centre, depending on the nature and quantity of fodder supplied, whether it is chaffed or not, etc. Usually, the fodder remains amount to about 2-5 lbs. per animal per day. In addition to the duug, urine and fodder remains, other

miscellaneous vegetable rofuse, collected on the farm, which cannot be used as fodder may also be available for manure preparation. The quantity of extra refuse so avilable is very variable, depending principally on the nature of crops grown on the farm. Tne quantity of inedible refuse collected on the farm is greatest where sugar-cane is grown (3 to 5 tons of trash per acre), less where cotton, castor, tur, jowar etc. are grown (1 to 1½ tons per acre) and least where cereals are grown. In the last case only the weeds and stubbles would form the extra refuse available. In most cases, the inedible refuse is at present burnt off as fuel, in order to meet the fuel needs of the farmer, or used for special purposes such as *gul* making.

3. *Management of the Cattle-shed*:—The fodder-remains, collected from the feeding bier each morning, should be kept aside and spread under the cattle the same evening so as to serve as bedding for them. A portion of the inedible extra refuse collected on the farm (vide section 2 above) may, after properly breaking them down, be mixed with the fodder-remains, to make a total weight of 10–15 lbs. per animal. The system of using dry litter and refuse as bedding, not merely encourages the decomposition of such litter, but also helps to absorb a good portion of the urine that may be voided by the cattle during the night. In presence of sufficient litter as bedding (10–15 lbs. per animal,) very little of the urine escapes into the drain in the cattle-shed. It is advisable, however, to cover the drains and urine soak-pit with a layer (1″ thick) of dry earth every evening and to scrape out the urine-soaked earth in the mornings for addition to the manure trench. Every morning, the whole of the bedding under the cattle, along with the dung voided, and urine-earth from the drains is gathered together and mixed properly in the cattle-shed itself and taken to the manure trench. Where weather coditions are hot and dry, and extra litter (above 5 lbs. per head) had been used as bedding for the animals, additional water (equal in weight to the weight of litter used as bedding) may be added, while mixing the litter and dung (1 gallon water=10 lb.). A test of the sufficiency of moisture in the mixed mass would be to take a handful of the mass in the hand, press gently and throw back; there should be moisture sticking to the hand. Excess of water should not be added and there should be no flowing out of water from the mass or moistening of the cattle-shed floor during

mixing with water. Where the cattle shed has *katcha* flooring (earthen), the portions of the flooring where urine has soaked down in the night should be scraped out horizontally with a shovel every morning and covered by dry earth stored near the cattle shed. The urine soaked earth should be taken to the manure trench and used for covering each day's refuse lot on top.

4. *Filling up the Trench* :—The trench is filled up from the shallower end, (where the depth is less), taking up small lengths of 2½ to 3½ feet at a time. To start with, a portion 2½ to 3½ feet length is marked out from the shallower end, and into this portion is deposited the morning's collection of mixed refuse from the cattle shed (bedding, dung and urine, mixed well), which may vary from a few baskets to a cart-load, depending on the size of the farm and number of cattle maintained. A movable *katcha* partition made of cotton stalks or jowar kadbi fixed between two bamboos can conveniently be used for marking out the portion of the trench from one end which is taken up for filling. As soon as the day's refuse is put in—suppose the layer comes to the height of one foot from the bottom of the trench—the *top* is gently pressed (not thumped) with a *phowda* (shovel) and is covered over with a layer (½ inch thick) of urine—earth brought from the cattle shed (about 20—50 lbs.). Where urine earth is not available, ordinary dry earth can be used. It would be a good plan to add portions of bone meal or charred bones and all wood-ash available on the farm to each day's layer of refuse, before the same is covered over with earth. This would serve to enrich the manure in phosphoric acid and to improve its quality considerably. The succeeding morning's collection of refuse from the cattle shed is deposited over the previous day's lot and covered with a thin layer of urine-earth as before. This is repeated over 5 or 6 days, till the level of the heap rises to a height of 1½ to 2 feet above the ground level, when the heap is made dome-shaped and the upper surface plastered over with earth about half an inch thick. This can be done easily by moistening the dome shaped surface with some water, pressing gently and throwing a *ghamela* or two of earth loosely so as to give a uniform layer of earth, covering the top of the heap. After the first 2½—3½ ft. portion of the trench is filled up as above, the next 2½-3½ ft. portion is taken up for filling in the same manner and the operation continued till the whole trench is completely filled

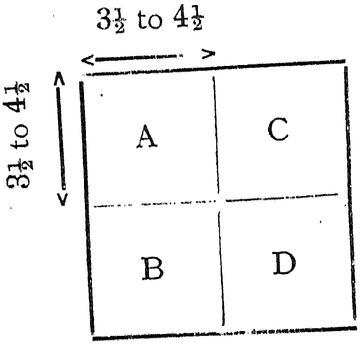
up. The manure is ready in about four months' time after packing. If after one or two months time, the level of the heap sinks down below ground-level, it should be raised again to 1½ to 2 ft. above ground-level by putting in fresh layers of refuse on top, and plastered over with earth as before. This precaution should be taken specially in rainy weather, in order to prevent rain water from getting into the trench.

5. *General*:—For an average farm, it would be necessary to have at least three such trenches. By the time the third trench is filled up, the manure in the first trench would be ready for being applied to land. A comparison of the improved method of farm-yard manure preparation outlined in this Note, with the present methods adopted by the farmer of preparing his manure in big-sized, uncovered pits or in over-ground heaps which are turned over a number of times and watered, would show that the improved method prevents heavy losses of nitrogen and of organic matter, minimses labour and watering charges considerably and yields a larger quantity of good type of manure. The nitrogen content of the manure (from 1. 5 to 2. 0% on dry basis) would be found to be nearly twice as much as is contained in farm-yard manure as ordinarily prepared by farmers.

PLASTERED HEAP METHOD OF MAKING FARM-YARD MANURE.

The trench method would be found suitable for most farms which maintain cattle for their cultural operations, and grow mixed crops (i. e. two or more different crops on different portions of the land). Where, however, large quantities of a uniform type of refuse have to be deald with, e. g. sugar-cane trash, cotton stalks, etc. as much of the above refuse as possible should, after preliminary breaking down under the feet of cattle or under carts or rollers, be mixed with softer refuse and used as bedding in the cattle-shed, and the rest should be mixed with the wastes obtained from the cattle-shed, and the whole mass should be composted by a modified system of over-gruund plastered heap—composting, details of which are given below. Overground heaps would also be necessary in cases where, due to high sub-soil water-level or in times of heavy rainfall, trenches are not possible. The instructions given in sections 2 and 3 above regarding management of cattle-shed, spreading of refuse as bedding, collection of spoilt litter, dung and urine and transport of the same to the manure heap would apply in *toto* to the present method, the only difference being that instead of the refuse being put in trenches below ground-level, over-ground heaps hre built up.

In the presend method, 4 smaller heaps A, B, C and D (each 3½ to 4½ ft. square base) are built in successive periods of time, in juxta position as shown in the diagram.



Each of the smaller heaps (A, B, C and D) may be about 4 ft. high, and in the case of the small scale farmer, may be built up by placing 3 to 4 days' refuse lots one on top of the other till the level rises to about 4 ft. above ground level. Each day's layer should be covered with a thin layer (about an inch thick) of dry earth or urine-earth brought by scraping out daily the wet areas in the cattle shed floor. If each of the smaller heaps A, B, C, and D takes about 3 days to build, the whole conjoint big heap A B C D would be completed in about 12 days; and at the end of this period, the mass is moistered with water, if necessary, the sides are drawn up slightly so as to form a hemispherical big mass and plastered over with earth, by throwing a few *gamelas* of earth loosely so as to form a thin layer all over the mass.

In the case of ordinary farms, where cattle are maintained and mixed crops are grown and the refuse contains enough dung and urine, no turning need be given to the heap and the manure would be ready in about 4 months' time. In cases, however, where the refuse contains comparatively little of animal excreta and more of resistant type of vegetable refuse low in nitrogen, *e.g.* sugar-cane trash, it would be advantageous to give a complete turning to the mass at the end of a month, with watering and preferably addition of fresh dung and urine. After the turning, the mass should be again plastered over with earth as before, in order to conserve moisture and heat and thus promote better microbial decomposition. Where the refuse is particularly low in nitrogen e.g. sugarcane trash and the crop to be manured would warrant the expense, it would be a good procedure to add organic or inorganic nitrogenous and phosphatic supplements at the rate of about 0·5 per cent nitrogen and phosphoric acid on the dry matter of the refuse, before subjecting the mass to the process of composting.

The plastered heap method involves more labour and requires more earth for plastering than the trench method; but in areas where trenches are not possible, the above additional labour is worth incurring, in view of the higher recovery of nitrogen and organic matter and the better conservation of moisture secured in the mass.

* * *

The position of Agriculture in the Central Provinces & Berar.

by

R. H. Joshi, M. Sc.
&
W. J. Kalamker, M. Sc.

THE problem of food-supply, due to the present crisis has become a matter of serious consideration for the people in every part and in every sphere of life in the country. The prices of food-grains have soared very high since the commencement of war, and all the provinces, to a lesser or higher degree, are sufferring from this inadequacy of food-supply and the high prices of food-grains. Numerous deaths are occuring in Bengal due to starvation.

One of the important means of meeting with this grave situation is to increase the production of food grains. The Government under the Grow more Food campaign is urging the cultivators to increase food production, and is giving them facilities such as takavi loans and subsidies for constructing wells and bunds, and manures such as cakes at low rates, and san-hemp seed for green-manuring free of cost, and in several other ways.

The object of this article is to place certain broad and vivid facts about the present position of agriculture in our province, to find out how far it is possible to increase production by adopting suitable means, and to bring to the notice of the cultivators the facilities afforded by the Government in this connection. The statistics represent, in general, the averages of five years ending 1938-39.

Rice

Rice is the main crop of the province, having an area of about 5.67 million acres or about 23 % of the total area under cultivation. It can be seen from the figures given below, that although the province stands fairly high as regards the area under the crop it stands more or less the lowest in India as regards the yield per acre.

TABLE I

A statement showing the area and the production, of rice, in various provinces.

Name of province or state	Area in million acres	% of total area under rice in India	Production in hundred thousand tons	% of production of rice in India
1 Bengal	21.91	30.24	84.17	35.50
2 Madras	9.91	13.68	45.90	18.06
3 Bihar	9.66	13.33	29.67	11.63
4 U. P.	7.15	9.87	20.72	8.16
5 C. P.	5.74	7.93	15.99	6.29
6 Assam	5.29	7.31	17.49	6.88
7 Orissa	5.11	7.05	14.50	5.71
8 Bombay	1.92	2.65	7.63	3.00
9 Sind	1.22	1.69	4.51	1.76
10 Hydrabad	0.97	1.34	3.46	1.36
11 Mysore	0.73	1.01	2.17	0.85
12 Baroda	0.19	0.26	0.38	0.15
13 Coorg	0.08	0.12	0.55	0.22

TABLE II

A statement showing the average yield of rice per acre in some important provinces in India.

Province or State	Yield per acre in lbs.
1 Coorg	1464.8
2 Madras	1045.2
3 Bombay	885.6
4 Bengal	859.4
5 Sind	825.8
6 Hydrabad	798.2
7 Assam	751.4
8 Bihar	715.0
9 Mysore	670.6

10	U. P.	....	649.2
11	Orissa	....	636.6
12	C. P.	....	623.8
13	Baroda	....	448.0

Juar

The next crop important in acreage in the province is juar. The area under this crop is 4.37 million acres or about 17. 9% of the total area under cultivation in the province. The tables given below show that the position of the province as regards this crop is satisfactory.

TABLE III

A statement showing the area under juar, and its production in various provinces in India.

	Province or State	Area in million acres	% of total area under juar in India	Production in hundred thousand tons	% of production of juar in India
1	Hydrabad	8.51	24.93	13.03	19.90
2	Bombay	8.30	24.33	13.72	20.96
3	Madras	4.96	14.52	12.62	19.28
4	C. P. and Berar	4.45	13.05	10.02	15.30
5	Bombay states	2.70	7.91	7.29	11.14
6	U. P.	2.23	6.53	4.53	6.91
7	Punjab	0.85	2.48	0.87	1.33
8	Baroda	0.66	1.98	1.01	1.54
9	Mysore	0.65	1.92	1.24	1.90
10	Sind	0.43	1.23	0.95	1.46

TABLE IV

A statement showing the yield per acre of Juar in some important Juar growing provinces in India.

	Province or State	Yield in lbs. per acre
1	Bombay states	605.0
2	Madras	570.1

Province or State	Yield in lbs. per acre
3 C. P. and Berar	504.0
4 Sind	494.0
5 U. P.	454.7
6 Mysore	425.3
7 Bombay	370.0
8 Hydrabad	344.0
9 Baroda	339·8
10 Punjab	229.1

COTTON

The area under cotton is 4.0 million acres or 16.3 % of the total area under cultivation in the province. Although the area under the crop and the production are quite satisfactory, the province stands rather low as regards the yield per acre.

TABLE V

A statement showing the area under cotton and its production in some important cotton growing provinces in India.

Province or State	Area in hundred thousand acres	Percentage of area under cotton in India	Production in 1000 bales of 100 lbs. each	Percentage of production of cotton in India
1 Bombay @	57·41	25·1	1139	21·7
2 C. P. and Berar.	38·55	16·2	730·4	19·6
3 Punjab @	36·38	14·4	1,372·0	26·2
4 Hydrabad	32·52	13·8	512·0	9·8
5 Madras @	21·29	9·8	427·0	8·1
6 Sind @ ...	9·41	3·6	394·0	7·5
7 Baroda ...	8·26	3·5	167·4	3·2
8 Gwaliar ...	6·40	2·6	105·2	2·0
9 U. P.	6·10	2·5	180·2	3·4
10 Bengal	0·86	0·3	26·6	0·5

@ Includes states

TABLE VI

A statement showing the yield per acre in some cotton growing provinces in India.

Province or State		Yield in lbs. of lint per acre
1 Sind	....	167·5
2 Punjab	....	150 8
3 Bengal	....	124·0
4 U. P.	....	118·0
5 Baroda	....	80·8
6 Madras	....	80·4
7 Bombay	....	79·6
8 C. P. and Berar	....	75·6
9 Rajputana states	....	70·4
10 Gwaliar	....	64·0
11 Hydrabad	...	62·8

WHEAT

The area under wheat in the province is roughly 3·30 million acres or about 13·5 % of the total area under cultivation. A comparison of the figures in tables given below shows that although the province stands third amongst the important wheat producing provinces, the yield per acre is very low,

TABLE VII

Porvince or State	Area in million acres	% of area under wheat in India	Production in hundred thousand tons	% of production of wheat in India
1 Punjab	9·55	27·76	34·33	33·90
2 U. P..	7·79	22·66	27·21	26·82
3 C. P. and Berar	3·29	9·57	6·40	6·32
4 C. I. States....	2·14	6·22	3·76	3·71
5 Bombay	1·74	5·07	3·09	3·05
6 Gwalior	1·54	4·46	3·66	3·61

Province or State	Area in million acre	% of area under wheat in India	Production in hundred thousand tons	% of production of wheat in India
7 Punjab States.	1·47	4·29	4·70	4·64
8 Rajpatana States	1·34	3·91	4·70	4·64
9 Hydrabad	1·25	3·63	1·69	1·67
10 Sind	1·13	3·29	3·30	3 26
11 Bihar	1·12	3·26	4·19	4.03
12 N. W. F.	1·01	2·93	2 59	2·55

TABLE VIII

A statement showing the yield of wheat per acre in some important wheat growing province in India.

Province or State		Yield in lbs. per acre
1 Bihar	...	837.2
2 Punjab	....	801·2
3 U. P.	....	782·4
4 Punjab States	....	714·2
5 Sind	....	659·4
6 Rajputana	....	599·4
7 N. W. F.	....	576·0
8 Gwalior	....	537·6
9 C. P. and Berar	....	434·6
10 Bombay	....	397·6
11 C. I. States	....	393·4
12 Hydrabad	....	301·8

LINSEED

The area under this crop is ronghly 1·30 million acres or about 5·3 % of the total area under cultivation. As compared with the other provinces, C. P. and Berar stand the highest as regards area. The yield per acre however is very low.

TABLE IX

A statement showing the area under Linseed and its production in some important provinces of India.

Name of Province or State	Area in million acres	% of area under Linseed in India	Production in thousand tons	% of production of Linseed in India
1 C. P. & Berar.	1·23	33·08	9·78	22·5
2 U. P.	0·63	21·35	10·8	24·8
	0·38*	7·45*	4·6*	10·7*
3 Bihar	0·56	15·12	8·00	18·46
4 Hyderabad	0·45	12·00	3·94	9.00
5 Bengal	0·14	3·65	2·50	5·74
6 C. I. States	0·125	3·37	0·68	1·56
7 Bombay	0·12	3·20	1·11	2·53
8 Rajputana Kota.	0·094	2·51	0·96	2·21
9 Bhopal	0·055	1·49	....	...
10 Punjab	0·030	0·82	....	....

**Mixed Crop*

TABLE X

A statement showing the yield per acre of Linseed in some important provinces of India.

Province or State	Yield per acre in lbs.
1 Bengal	408·8
2 U. P.	380·6
3 Bihar	318·0
4 Bhopal	259·8
5 Rajaputana (Kota)	247·2
6 Punjab	213·2
7 Bombay	207·4
8 C. P. & Berar	177·6
9 E. Agency States	126·4

GRAM

The area under this crop is roughly 1·19 million acres or about 5·3 % of the area under cultivation. As seen from the tables given below the position of the crop is for from satisfactory in every respect.

TABLE XI

A statement showing the area under gram and its production in some important provinces in India.

	Province or State	Area in million acres	% of area under gram in India	Production in hundred thousand tons	% of production of gram in India
1	U. P.	5·76	37·5	12·87	36·2
2	Punjab	3·62	24·5	6·84	19·2
3	Bihar	1·38	9·0	4·32	12·1
4	Hyderabad	1·25	8·1	2·00	5·6
5	C. P. & Berar.	1·14	7·4	2·09	5.9
6	Mysore ...	0·80	5·2	0·69	1·9
7	Bombay	0·62	4·6	0·93	2·6
8	Sind	0·34	2·2	0·47	1·3
9	Bengal	0·27	1·7	0·74	2·1
10	N. W. F. Province	0·16	1·0	0·26	0·74

TABLE XII

A statement showing the yield per acre of Gram in some important provinces of India.

	Province or State		Yield per acre in lbs.
1	Bihar	....	702·3
2	Bengal	....	607·9
3	U.P.	....	500·5
4	Punjab	....	423·8
5	C. P. & Berar	....	411·8
6	N. W. F. Province	....	370·0
7	Hydrabad	....	357·7
8	Bomby	....	332·7
9	Sind	....	314·7
10	Mysore	....	191·9

Seasame

The area under til is roughly about 0·45 million arces or about 1 8 % of the area under cultivation in the province. Although the area under the crop and the production are satisfactory, the yield per acre is very low.

TABLE XIII

A statement showing the area under til and its production in some important til growing provinces in India.

Province or State	Area in million acres	% of area under til in India	Production in thousand tons	% of production of til in India
1 U. P.	0 92 0 31* crop)	29·15 . crop)	82·4 27·4* crop)	25 78 .... crop)
2 Madras	0 79	18·64	93 0	21·78
3 Hydrabad	0 51	12·12	34·8	4·23
4 C. P & Berar	0·45	10 76	35 8	8 40
5 Bombay States	0·31	8 55	46.0	10·80
6 Bengal	0 17	4·02	37 0	8·71
7 Bombay	0 17	4·00	18 0	4·23
8 Bihar	0·12	2·76	16·4	3·85
9 Orissa	0 11	2·59	13 6	3·19

*mixed crop

TABLE XIV

A statement showing yield per acre of til in some important til growing provinces of India.

Province or State	Yield in lbs. per acre
1 Bengal	446·4
2 Bihar	316·8
3 Bombay (States)	284·0
4 Orissa	279·4
5 Madras	264 6
6 Bombay	237·6
7 U P.	200·8
8 Rajaputana (Kota)	195·0
9 Punjab	180·2
10 C. P. & Berar	176·6
11 Hydrabad	152·4
12 Baroda	127·0

Ground-nut

The area under ground-nut is on an average 0·17 million acres or about 0·69 % of the total area under cultivation in the province. The position of the province as regards the area under the crop, production and the yield per acre is satisfactory.

TABLE XV

A statement showing the area under ground-nut and its production in some important provinces of India.

Province or State	Area in million acres	% of area under ground-nut in India	Production in hundred thousand tons (nuts in shell)	% of production of groundnut in India
1 Madras	3·61	48.23	16·51	56·16
2 Hydrabad	1·33	17·74	4·22	14·35
3 Bombay	1·22	16·26	4·89	16·63
4 Bombay–States	0·92	12·22	2·82	9·58
5 C. P. & Berar	0·20	2·70	0·55	1·88
6 Mysore	0·20	2·70	0·38	1·29

TABLE XVI

A statement showing the yield per acre of ground-nut in some important provinces of India.

Province or State.		Yield in lbs. per acre (nuts in shells)
1 Madras	....	1028·8
2 Bombay	....	913.4
3 Hydrabad	....	708·0
4 Bombay States	....	701·8
5 C. P. & Berar	....	611·8
6 Mysore	....	411·8

Sugar-cane

The area under sugar-cane is about 0·032 million acres or only about 0·13 % of the total area under cultivation in the province. The area under the crop and the production are thus the lowest as compared with the other provinces. C. P. & Berar are required to import almost all the sugar needed for consumption. The yield per acre of the crop is also low.

TABLE XVII

A statement showing the area and the production of sugar-cane in some important provinces of India.

	Province or State	Area in million acres	% of area under sugar-cane in India	Production in hundred thousand tons	% of production of sugar-cane in India
1	U. P. ...	1·96	53·1	22·46	48·15
2	Bihar and Orissa	0·45	12·34	4·89	10·48
3	Punjab	0·44	12·10	3·62	7·77
4	Bengal	0·31	8·43	4·92	10·54
5	Bombay and Sind	0·15	4.09	3·50	7·49
6	Madras	0·12	3·30	3·45	7·59
7	N. W. F.	0·077	2·08	0·82	1·75
8	Assam	0·060	1·62	0·41	0·87
9	Mysore	0·047	1·26	0·75	1·61
10	Hydrabad	0·036	0·97	0·77	1·64
11	C. P. and Berar	0·030	0·82	0·52	1·11

TABLE XVIII

A statement showing the yield per acre of raw-sugar (gur) in some important provinces in India.

	Province or State	Yield in ~~lbs.~~ tons. per acre
1	Baroda	3·63
2	Madras	3·08
3	Bombay ...	2·40
4	Hydrabad	2·17
5	Bengal	1·60
6	Mysore	1·54
7	C. P. & Berar	1·47
8	U. P.	1·19
9	N. W. F.	1·11
10	Bihar & Orissa	1·10
11	Assam	1·04
12	Punjab	0·79

TABLE XIX

Area under irrigation

The table given below shows that the irrigation facilities in the province are very poor, as compared with other prouinces.

Province or State		Total cropped area in million acres	Area under irrigation in million acres	Percentage area irrigated
1 Punjab	....	27·57	15·12	54·8
2 N. W. F.	....	2·25	1·00	44·4
3 U. P.	....	35 98	10·69	29·7
4 Madras	....	31·57	8·70	27·5
5 Orissa	...	4·88	1·25	25·7
6 Bihar	...	19·53	4 35	22·3
7 Assam	...	6·26	0·64	10·2
8 Bengal	....	23·84	1·77	7·5
9 Hydrabad	....	28·20	1·50	5·3
10 C. P. & Berar	....	24·48	1·21	4·9
11 Bombay	...	28·47	1·09	3·8

Classification of areas

The following table shows the classification of area of the important provinces in India. Leaving aside such provinces like Assam, Orissa, N. W. F., C. P. & Berar stand the highest as regards the culturable waste land. The province can thus bring, about 57. 2 % of its total area under cultivation, which is at present a culturable waste land.

TABLE XX

Classification of areas in different provinces and States in India.

Province or State		Total area in million acres	Area under cultivation in million acres	Current fallows	Culturable waste	% age of culturable waste to total area
1 Madras	....	79·99	31·57	9·61	10·75	34·1
2 U. P.	....	67·97	35·98	2·68	10·13	28·2

3	C. P. & Berar.	63·09	24·48	3·84	14·01	57·2
4	Punjab	60·71	27·57	3·52	14·24	51·7
5	Bengal	49·25	23·84	5·08	6·28	25·9
6	Bombay	48·72	28·47	5·27	8·76	30·8
7	Hyderabad	45·26	23·23	3·88	1·86	6·6
8	Bihar	44·32	19·53	6·85	5·14	26·3
9	Assam	35·48	6·26	1·61	18·94	302·5
10	Orissa	30·12	4·88	5·06	5·89	120·7
11	Mysore	17·49	6·30	1·58	1·04	16·5
12	C. I. States....	12·12	5·05	1·49	1·91	37·8
13	N. W. F.	8·58	2·25	0·57	2·78	123·5

DISCUSSION

From the foregoing tables it is very apparent that although the province stands well as regards the area under cultivation of crop the yield per acre in most cases is very low. Bal has pointed out that this low yield, in general, and the province in particular, is due to continuous cropping without any attempt being made to maintain the fertility of the soil. He has also pointed out that the condition of the soil is ameliorated by adopting adequate means such as bunding to prevent erosion and proper drainage, so as to give a better yield. Another important reason for such low yields is that the area under improved seeds has not spread to the extent it should. Besides, the crops have to depend mostly on rain-water in the absence of irrigation facilities to any large extent. Only 5% of the land sown is under irrigation and although this figure is comparable to that of Bombay, Hydrabad and Bengal, most of this land is irrigated by wells and tanks only; whereas in the case of the latter the irrigation is done by rivers.

The yield could substantially be increased by the application of manures. The important sources of these are the farm yard manure, vegetable waste matter and oil cakes. By proper preservation of farm-yard manure, the preservation of urine earth and composting of organic matter the supplief could considerably be increased. The Imperial Council os Agricultural Research has sanctioned a scheme of town refuse composting and the adoption of this process on a large scale would greatly add to the manurial resources. Oil cakes are not being utilised to any great extent and under the present conditions, when the aritificial manures are unobtainable they need to be explored to the fullest extent. A scheme has been sanctioned for the distribution of oil cakes for manuring and if the people take advantage of the facilities production could substantially be increased. Addition of oil-cakes to paddy at the rate of five maunds per acre would result in the increased yield of about 224 lbs. per acre and would give an additional net profit of about 85 Rs. per acre after meeting the cost of oil-cakes. Another scheme is for the distribution of san-hemp seed for the green manuring of wheat and paddy lands, for which san-seed is being supplied free by the Department. The provincial Government has also allowed the free removal of tank-silt from tank beds for manuring the fields. If the cultivators take advantage of the facilities offered, increased yields could be obtained with economic results.

As will be seen from the last column in table No. 20, in most of the provinces there is yet a good percentage of land that could be brought under cultivation. Taking India as a whole, the culturable waste is roughly about 40% and in C.P. & Berar it is as high as 50% of the total area sown. As pointed out by Mukerji the co-efficient of over-population in the province is below one and hence the cultivators do not feel the necessity for taking the axe and the plough for increasing the area under cultivation. But in view of the seriousness of the present food position in India and the good prices which the food grains fetch, it is in the interest of the cultivators and the public in general to break as much fallow land as possible and put it under food crops and also to divert some area under non-food crops to food crops. It is gratifying that there is already a response in this direction. Upwards of two lakhs of acres of fallow land have been broken this season in this province, under the stimul us of high prices and the propaganda of the Department, but there is still further scope in this direction. The Government is distributing free gram seed for such newly broken lands and the fullest advantage should be taken by the cultiva tors, of this concession. It may be pointed out, here as a caution that the necessity of preserving good pasture land for the cattle may not be neglected.

As a result of granting Rs. 2 per acre as subsidy to cotton growers who had reduced their cotton acreage during 1942-43, the area under cotton fell by about 16% over the 1941-42 average. In the current season again it is estimated that the area will still further be reduced by about 7% over the last year's figures inspite of the fact that no subsidies will be granted this year. All such land diverted from cotton is estimated to be put under food crops. It is encouraging to note that the cultivators are realising the seriousness of the food situation and increasing the area under food crops.

The facilities afforded by the Govt. for the digging of more wells and earth embankments for converting rabi land into do-fasli if taken advantage of by the cultivators would give money return to them and result in permanent improvement of their lands.

This is an opportunity for the cultivators to serve their country and to serve themselves by growing more food.

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3	,,	1939-40 Estimates of Area and Yields of principal crops in India.	Govt. Publication
4	,,	1937-38 Agricultural Statistics of India.	,,

Government's Scheme of Financing Well Irrigation.

ONE of the main problems in connection with the increased production of food crops and the security of cultivation is the lack and insufficiency of irrigation facilities. Government has been examining the question as to how this difficulty can be overcome and considers that in places where irrigation from tanks is not available, every encouragement should be given for the construction of wells, particularly in the cotton areas where lands under cotton can be advantageously diverted to food crops. Government accordingly, with the help of a loan from the Government of India decided on a programme for the construction of wells, particularly in the cotton areas and effect is now being given to it. The scheme is to grant taccavi loans to the extent of the actual cost of construction (inclusive of the manual labour put in by the cultivator and his family) subject to a maximum of Rs. 500 per well, the amount being repayable in 5 years. The advance will bear interest at the concessional rate of 3½ per cent per annum, the cultivator being liable to return only Rs. 80 out of every Rs. 100 advanced, on condition that he binds himself to grow only food crops under the well during the next three years and does not grow a larger total area under cotton in 1944 than he grew in 1943. It is proposed to finance 2,500 wells in the cotton and 1,000 wells in the non-cotton areas. The total cost involved on the scheme will be Rs. 17,50,000 out of which Rs. 14,00,000 will be loans and Rs. 350,000 subsidy.

A survey of the possibilities of this scheme showed further that there are a substantial number of old wells, particularly in Berar, which have fallen into disuse, due to insufficient depth, silting or lack of repairs. Generally speaking, their owners having taken up cotton cultivation and have not thought it worth their while to keep them in working order and hence much of their original usefulness has been lost. Government is accordingly offering in the cotton tracts the same concessions and financial facilities as have been given in the case of new wells, the only exception being that the assistance in each case will be limited to Rs. 200. A provision of Rs. 1,60,000 for advances and Rs. 40,000 for subsidies has been made under this head for the repairs of 1,000 wells. The total scheme therefore provides for the construction of 3,500 new wells and repairs of 1,000 wells against a total expenditure of Rs. 15,60,000 for advances and Rs. 3,90,000 for subventions.

As well irrigation is useful not only for rabi crops but also for vegetables, it is hoped that cultivators all over the province wlll not fail to take full advantage of this generous offer which is operative till June 1944, and which will be profitable not only from the long-term point of view, but will also provide useful subsidiary employment at their very doors at a season when there is leisure from their main agricultural operations.

—[*C. P. & Berar Reniew, Vol. I, No. 6, Feb. 15th, 1944.*]

Cultivation and Curing of Turmeric.

By

DHANNALAL.

General:—It is a crop which is extensively grown all over India. Its rhizome are either used in the preparation of the well known condiment used in curries or for the extraction of dye. The former is however, its chief use.

Varieties:—There are two distinct varieties under cultivation and both are edible, (a) with hard, rich coloured rhizomes from which the yellow dye is practically obtained, (b) with softer larger lighter coloured rhizomes.

Soil:—Any soil of fair depth will do for growing this crop except badly drained off stiff clay and stony and gravelly soils, but does best on naturally well and readily drained soils which are best capable of growing irrigated garden crops, such as well drained medium black soils or deep free working alluvial or loamy soils. Lighter discriptions of soils are better suited for this crop when it is to be raised under irrigation.

Mixture:—Turmeric is grown to a large extent as a single crop but occasionally it is raised as a subordinate crop to ginger, as the cultivation of both these crops is similar.

Season:—The crop is invariably planted in the beginning of the rains but the exact time of planting depends upon local conditions, in particular upon the availability of water for irrigation. It does best when it is planted in मृग नक्षत्र (7th to 22nd of June). Its growth extends into the rabi season and thus necessitates irrigation.

Cultivation and manuring:—The land should be ready for planting by the end of May, so it is desirable to begin the preparatory tillage immediately after the removal of the previous crop. It should be carefully done. The time to begin this, depends on the removal of the previous crop but commencement should be made early in April at the latest by ploughing and cross-ploughing the land with either iron plough or country plough. If the land is hard, it should be watered to admit of ploughing. Turmeric planted after cane is not manured as a rule, but in other cases early in May about 30–40 cart loads of well decayed Farm Yard manure, or sheep folding at the rate of 5000 sheep per night per acre, or 20 mds. of well powdered oil-cake are applied to the ploughed land and this is thoroughly mixed with the soil by frequent ploughings and cross ploughings. The land is ploughed as often as in necessary to loosen the soil to a considerable depth about 8″ deep and to secure a fine state of tilth. If left untouched for a fortnight after ploughing in the 1st week of May, the surface becomes quite friable. This is again worked with country ploughs 2 or 3 times with a view to eradicate the annual weeds which spring up early in June after the soil has been well soaked with rain. To obtain a loose and deep surface six to eight ploughings with country plough are needed which secures a proper condition in the soil. After thorough preparation of the land, the surface is levelled with a pather. The land is then ridged up with the plough 9″—10″ high 24″—36″ apart, the furrow being as deep as possible. The plough is then run across the line of the ridges to form parallel water channels 12′ apart. Finally the field is laid out into beds 12′ square or if the ground is uneven, the beds may be smaller. The bandh round each water compartment should be raised by soil moved from the furrows and by removing about 9″ of soil from the ends of two alternate ridges in side any particular compartment. Each compartment when complete, contains 4 short ridges and five furrows. Besides this, the broad-ridge method has also been found very useful on the College Farm. In this method the land is laid out into ridges and furows, the latter being 4′ apart while the intervening space forms the flat ridge 2½′ in width.

For purposes of planting well developed sprouted disease free sets are to be selected. Sprouting can be induced by heaping up the rhizomes in a dark and cool place. The heap is covered over with leaves which are plastered down with a pasty mixture of cowdung and earth. In about a month's time, the sets begin to sprout. After the rains have set in these are planted in 2 rows on the bed 1′ apart, the same distance being maintained between plant to plant. Each set is placed in a pit about 2″ deep carefully covered up with the soil. Roughly almost 1000 to 1200 lbs. of turmeric green sets are required per acre.

Drainage:—The turmeric crop should be thoroughly drained by digging deep trenches between the beds and water should be let out from the field whenever it accumulates. The raising of a successful crop largely depends upon thorough drainage and aeration of the soil.

Top dressing and earthing:—When the plants are about a foot high, finely powdered castor cake at the rate of 10 mds. per acre and 200 lbs. niciphos II are spread evenly near the roots of turmeric and earthing is done along the natural inclination of the land, to exclude water from the immediate surroundings of the plant. Earthing should be finished before the end of July so that the crop may have sufficient time to make use of the concentrated manure given. After this the crop requires no attention except careful and regular irrigation till it is ripe.

Irrigation:—Immediately the sets of turmeric are in the ground, water is given. On the lighter descriptions of soils, if turmeric is planted in May before the break of the regular monsoon, it is watered regularly every 4th day and on medium black soils every 6th day until the rains. If, thereafter, there is a break in the rainfall of more than 10 to 12 days, duration, irrigation is resumed every 8th day. When the rains cease irrigation is required once a week until the crop is ripe. Only 5 or 6 irrigations are required on heavier soils (free working clay-loamy soils).

Weeding:—The crops need weeding from time to time. This should be thoroughly done by going over the crop from 6 to 8 times with khurpies according to the condition of the field Flowers, as soon as they are formed, should be removed. The removing of flowers will direct all the energy to the formation of the rhizomes.

Storage of seed in the fresh state:—The rhizomes when completely dried are sorted and the small outgrowths of the root are set apart for seed and stored in a cool moist and well ventilated place. These sun dried sorted turmeric roots are built in a heap which when finished is covered with dry dead turmeric leaves or rice straw. The heap is then plasted with cattle dung.

Harvesting:—The crop gets ready for harvesting by the end of January or in the beginning of the February. The rhizomes are removed after the withered leaves and stalks have been cut off. The crop is then sorted into (a) fingers (b) old seed (e) round tubers. The fingers and old seed are cured for the market, while the round tubers are preserved for the next season.

Preparation for market:—Before being offered for sale, the roots have to be cured. The green roots after removing from the ground are perfectly dried. Adhering earth is then removed from the roots which are then washed and sorted. The small rootlets are also completely removed. These dried, cleaned and free of earth rhizomes are either boiled in a gur boiling pan or copper vessel or earthen pot. A large or small quantity of these rhizome, are placed in the pot and water just sufficient to cover the roots is added. This is then covered with gunny bags or the dried leaves of the turmeric plants. The lid is put over the mouth and plastered and the pot is set on fire to boil slowly for about 3 hours. In some cases, cow-dung is stirred up in the water used for boiling. The boiling is complete in about 3 hours, depending upon the regularity of fuel feeding. The test for complete boiling is to take some rhizomes especially from the top or the centre and press them between the fingers and if they are well cooked they will feel soft; or thurst a hard stick into the cooked tubers and if it penetrates easily, the stuff is supposed to be well cooked and ready for further treatment.

The whole stuff is then allowed to cool slowly as the fire gets gradually extinguished. On cooling the plastered lid is removed, the water is thrown away and afterwards the turmeric is taken out and spread in the sun for about 12-15 days depending upon the intensity of the sun. While drying the material should be stirred occasionally to ensure uniform drying. It takes about a week, for drying depending upon the weather conditions.

During the night the material is heaped and covered over to protect it from dew. After the stuff is thoroughly dried, it is rubbed in order to remove the outer skin by rubbing or treading under foot or by shaking the roots in the bamboo basket. When the stuff acquires the usual turmeric colour it is ready for the market. It takes one hour for 4 men to rub 40 lbs. of dried and boiled stuff. The crop after curing is reduced to about a sixth of its original weight of green rhizomes. 1400 lbs. of turmeric gives about 240 lbs. of cured and polished rhizomes which works out to be 17·1 %. With the completion of this operation which takes about a week the roots are ready for sale and will bring from Rs. 30—40 per khandy of 55 lbs. according to the quality of the crops and the state of the market.

Cost of Cultivation of Turmeric Crop per acre.
(on light (Sahra) soil).

		Rs. as. p.
1. Irrigation charges per acre. ...		3 13 0
(a) 2 men	0 12 0	
(b) 1 pair of bullocks	0 12 0	
2 days & a half per irrigation.	1 8 0	
2. Manuring 20 C. L. F. Y. M. @ 1 8 0 ...		30 0 0
3. Spreading charges 8 women. @ -/3/- ...		1 8 0
4. Ploughing charges		5 6 8
5. 2 Bakharings		1 15 0
6. Fertilizers ... ... 140 lbs. Ammonium Sulplate plus 200 lbs. Super phosphate plus 80 lbs. of potassium sulphate		24 3 0
7. Spreading Charges 2 women @ -/3/-		0 6 0
8. Opening furrows and making into beds and channels		3 6 0
2 men	0 12 0	
1 pair of bullocks	0 12 0	
5 men to dress ...	1 14 0	
	3 6 0	

9. Cost of rhizomes 1500 lbs. @ 20 lbs. yer rupee....		75 0 0
10. Planting	....	4 2 0
(a) 4 men for digging holes	1 8 0	
(b) 14 women to plant ...	2 10 0	
11. Irrigation (well irrigation) 22 @ 4/8/- each	...	99 0 0
12. 3 weedings (10 women per acre each weeding)	....	5 10 0
13. Removing flowers	....	1 8 0
14. Earthing—30 female coolies	....	5 10 0
15 Harvesting ...	....	20 4 0
(a) Cutting leaves 8 women @ -/3/-		
(b) Removing leaves 2 women @ -/3/-		
(c) Digging 16 men @ -/6/-		
(d) Cleaning rhizomes 66 women @ -/3/-		
16. Land Revenue and other cesses	....	5 5 0
17. Watching charges (proportionately)	....	1 0 0
Total	...	287 15 8
Mean yield 12000 lbs. (it varies from 8000 to 16000 lbs.) @ 30 lbs.	Rs.	400 0 0
Net profit	....	112 0 4

or roughly Rs. 100/- per acre.

* * *

Down with the plow.

ONE of the most revolutionary ideas in agricultural history last week had the general approval of U. S. Department of Agriculture officials. The idea: that the plow is a great enemy of man.

Chief exponent of this theory is an Ohio experimental farmer named Edward H. Faulkner. He believes that plowing is responsible for erosion and most other ills of the U. S. soil. He tested his theory by using a cultivation method of his own; instead of plowing he disk-harrowed the soil and planted his crops in the chopped-up surface stubble, weeds and debris. His harvest was astonishing. Many a farmer who reads his newly published report (Plowman's Folly; University of Oklahoma Press; S2) may be tempted never to plow again.

A Kentucky farmer's son, longtime county agent and agricultural teacher, Faulkner for 25 years has badgered farmers to tell him why they plow, claims that he never got an answer that made scientific sense. Most farmers plow, he concludes, mainly because they like to. Why is it, Faulkner asks, that when crops in a plowed field become parched and yellow, the weeds in unplowed adjoining fence-rows still grow lush and green? Why do plants in meadows and forests grow prodigiously without cultivation? Because, answers Faulkner, they are fed and protected by decaying plants on the surface of the soil. Plowing buries this organic material beyond the reach of most roots. Besides depriving the new crop of food, the buried vegetation forms a blotter that soaks up moisture from above and below, draws it away from the surface, where it is needed.

The result, Faulkner points out, is to render the bare soil a ready prey to drought or erosion by rain. Appalled at the damage done by the moldboard plow during its 200 year history, Faulkner observes that with all their machinery U. S. farmers get less yield per acre than Chinese peasants............”

Fruitful Trash:—Faulkner rented a farm and conducted a serious test. He grew a thick cover crop of rye, harrowed it in, planted in a surface that looked more like a trash pile than soil. He used no commercial fertilizer, no insecticides. He shocked neighboring farmers by his unorthodox method of planting tomatoes: he simply laid each plant on top of the packed soil and threw a little dirt on its roots. Within 24 hours every plant stood up straight. The source of this idea was an old textbook picture of a seedbed. Faulkner noticed that while the seedbed was dry, a heelprint in it looked moist; from this he developed his theory that the soil's capillarity (its ability to to draw moisture from below) is improved if it is packed rather than loose.

Faulkner's neighbors were still more amazed when they saw the fruit of these monkeyshines. Faulkner's tomatoes, heavier than average brought premium prices; he grew sweet potatoes in two months instead of the normal four; he harvested five pickings of beans instead of the usual one or two.

Bearded Soil:—Farmer Faulkner is sure, on the basis of these results, that abandonment of the moldboard plow would result in immensely richer crops without artificial fertilizer, lime, insecticides or even cultivating. His method, says he, would ultimately conquer insects (because bugs would find the crops less tasty) and weeds (because they would be killed off as they came up; weed seeds would not be buried and stored for future trouble, as they are by the plow). To the anticipated objection by most farmers that Faulkner's "bearded soil would be harder to handle than clean plowed land, Faulkner replies; let machinery makers develop new devices to do the job.

Last week the top U. S. soil expert, Soil Conservation Director Hugh Hammond Bennett, saluted Faulkner, Bennett pointed out that some pioneering farmers (notably United Fruit Co. and some Cuban sugar-cane growers) have long used a system of cultivation like Faulkner's, called "stubble mulch". The moldboard plow, agreed Bennett, is doomed, except for some special crops and uses.

In its stead, the Department of Agriculture urges farmers to practice "subsurface tillage" a method using new machinery that cuts off weeds below the surface, leaves the soil with a fertile beard.

—(*Extract:—U. S. A. Weekly News Magazine, Vol. XLII. No. 4, July 26th. 1943*

College Day Celebrations

Address

by

Sir Geoffrey Pownall Burton,

M.A. (Oxon.), K.C.I.E., I.C.S.,

Adviser to H. E. the Governor, Central Provinces and Berar.

Mr. Principal, Members of the Staff and Students,

I must begin by thanking Mr. Churchill and your General Secretary for the far too kind words in which they have welcomed me, and I am afraid I cannot claim to possess all the qualifications with which they have endowed me. Otherwise, I feel that you would regard me as a kind of encyclopædia of information. I was glad to note the very friendly applause which greeted the mention of the name of your former Principal and Director, Mr. McDougall and the welcome you accorded to your new Director, Mr. Hill. Those of you, who have not yet heard, will be glad to know that we have had news of Mr. McDougall's safe arrival in Britain and by now no doubt he is engaged in the cultivation of his native land of Scotland. It gives me great pleasure to join you this afternoon at your annual function. Though this is the first time I have had the opportunity of attending, I have had at least a nodding acquaintance with your College for over thirty-four years and have known well the able Principals, who have presided over its destinies; and in the past few years I have been more closely associated with it in the administration of the Department of Agriculture. The fact that I have not had the opportunity of being present before at this family gathering is, I may say, due to the fact that I was not invited and I esteem it a real privilege to be invited to what is primarily a family gathering of your own. Your Principal mentioned

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(Delivered on 14th December 1943 at the College of Agriculture, Nagpur.)

that your own hall is being occupied by the Marketing Section of the Department. We are grateful for the loan of the hall and apologise for the trespass on your premises.

Instead of indulging in the personal reminiscences that are not infrequent on these occasions, I would prefer to recall a few of the mile-stones that mark the 37 years record of the College. It was established in 1906, the year in which our province assumed its present form as the Central Provinces and Berar, and its educational course was one which culminated in the grant of a Diploma in Agriculture. In 1915 the College was enriched by the establishment of the very fine Agricultural Research Institute, of which we are so justly proud. After the foundation of the Nagpur University, in 1925 came the affiliation of the College with that authority, and the diploma gave place to the University degree of B. Sc. (Agriculture). In 1935 provision was made for Post-Graduate Research leading to a Master's degree in Agriculture. From the first the College has enjoyed the advantage of being residential. I had the pleasure of being shown round the Hostel by Mr. Churchill a few months ago and I was impressed by its comfortable and homely atmosphere. I was very glad to be instrumental in securing the removal of the nuisance from which it formerly suffered; this was not too easy to do but we got it done. The College is, I am glad to say, represented in the administration of the province by a number of its old *alumni* and we may, I think, confidently look forward to an increasing number. This steady progress may be fairly attributed to the tenure of the principalship by a succession of able and devoted agriculturists who have rightly taken pride in their College.

Now let us turn to the prospects that present themselves for the future. On every hand, on the public platform as well as in leaders in the newspapers, we have been told of the need for greater production, and anxiety is being expressed regarding the food position of the world at large and practically of every country in it. In most parts of the world, not excluding India, the ravages of war have made inroads into, or have made their effects felt upon, the granaries of the world. In many countries cultivation has suffered and food stocks have become depleted. These stocks have got to be replenished, and the land, if not improved, at least restored to its pre-war fertility. There is a universal demand not only for the extension of cultivation but for its improvement and intensification. You are, of course, all aware that prominent amongst the declared articles of the charter for the new world order stands out freedom from want, that is primarily the satisfaction of the need of mankind for their daily bread. All this means an insistent call to the farmer to give of his best, and this call will be echoed long after the war is over. Now, if the farmer is to be able to give the full response that is required, he will have to continue to work his hardest and to get the most out of his land, and for these purposes he will need the advice and assistance of trained and scientific agriculturists to help him in his task. This is the objective of the *Grow More Food Campaign*, which has been in progress in this country and particularly in this province in the last year or so; for we are predominantly an agricultural province and we must be ready to play our part in building up the foundations of peace and plenty for the new order. Plans for this campaign have been outlined in the report of the Foodgrains Policy Committee, which was recently published, and prominent amongst the conclusions reached in their deliberations upon the Grow More Food Campaign is that which recommends that Provincial and State Governments should take steps to increase the strength of their departments of agriculture. This is a matter which every administration will have to plan and pay increasing attention to in the early future. In this connection, I have noted and will bear in mind the remarks which your General Secretary has made regarding the difficulties attending employment in our own Department of Agriculture.

There is another aspect to be considered in the future of agriculture. With the return of peace, there is likely to be a speeding up of the process of industrialisation and in countries like ours which are predominantly agricultural, the existing relation between agriculture and industry may be disturbed. In the interests of the country as a whole we may look forward to rationalisation in the location of industry and to the extension and development of industry especially in areas like ours where raw materials are to be found alongside of the means for the production of power and the labour to exploit them. The further the process of industrialisation expands, the greater will be the turn-over of man-power from field to workshop. All the greater, therefore, will be the need for the efficiency of cultivation to keep pace with this process, in order to be able not only to provide food for the workers, but also to sustain the rise in the general standard of living which should follow in the wake of industrialisation. In his admirable address which we heard yesterday in Convocation, a leading Indian industrialist, while advocating a well-planned industrial revolution, emphasised the need for a proper balance between agriculture and industry, which he referred to as the marriage of town and of country, of industry and agriculture, between which there can be no incompatibility of interests. And in a few impressive sentences he stressed the problems presented in the improvement of agriculture and the condition of the vast agricultural population of this country. I would ask you all, even those who listened most attentively to that address, to read it again at your leisure. As I listened to the speaker yesterday, I felt that he had said almost all that is to be said on the subject and that perhaps I could not do better than repeat the words which he spoke instead of making a speech of my own.

To sum up, it seems to me to be a certainty, so far as anything in this world can be certain, that there will be increasing scope for the application of the science of agriculture to the practical need for increasing the productiveness of the land; and the man who has got himself trained and qualified in the science and practice of agriculture will find a demand, and an increasing demand, for his services and the prospect of a widening sphere of usefulness opening, before him. This, I think, is the finest encouragement that any of you in this College could have to do your best, whether in practical working in the field or in study in laboratory or lecture hall, to learn all you can and acquire all the skill you can to qualify yourselves for your part in the intensive and progressive improvement of agriculture.

Now I would moralise a little if I may. With all these prospects before you, I would suggest to you the thought that it is more important how we live and what we are than what we are to become, and as a charming writer—Robert Louis Stevenson—remarked "It is better to travel happily than to arrive". By 'happily', I think, the writer meant the habit of finding happiness in disseminating *happiness* around us and in relieving suffering so far as we can. Such *happiness*, I believe, is to be found most in service to others, i. e. service to our home, our village and community and to our country, rather than in the pursuit of personal ambitions and attainment of what have been called the glittering prizes of a career. With this thought in mind, I was particularly interested and gratified to learn what your College has done to assist those who have suffered in Bengal. I understand that means were found for this purpose by your self-denial in the way of saving expenditure on entertainments and similar objects. It is indeed a great credit to you all to have made such a generous contribution to the Bengal Relief Fund.

Lastly and before I close, I should like to congratulate those who have distinguished themselves and won prizes and wish them well in their future. For those who have not been so fortunate as to win a prize this time, I would hope that your turn will come next time.

* * *

College and Hostel Notes.

COLLEGE DAY CELEBRATIONS 1943.

Sports:—The sports meet was held on the morning of Sunday the 12th December. Various races in running and competitions in jumping were held. Mr. C. S. Iyer of the III year was adjudged the best sportsman of the year. In the afternoon a Cricket match was held between members of College staff and past students vs. the present students, in which the former won. Other sports events took place on the 13th which included the Inter-class tournaments in Hockey, Football, Volley Ball, Basket Ball and Hu-tu-tu. A swimming competition was held at the Telankheri tank. Great enthusiasm was shown by the students and members of the staff in these tournaments.

Prize giving and address:—The function was held on Tuesday the 14th December in the well decorated hall of the V. T. I. It was our good fortune this year to have secured the distinguished presence of Sir Geoffrey Burton, Adviser to H. E. the Governor, C. P. and Berar to preside over the occasion and to address the gathering. Mr. R. H. Hill, Director of Agriculture, Mr. Churchill, Principal, and the General Secretary welcomed the guests at the entrance.

The programme commenced with the opening remarks by the Principal. He introduced the guest of honour as one of the ablest men in the Civil Service, rich with experience and mentioned the love he bears towards agriculture. He further referred to the additions made to the equipment of the College, the opening of the Air Training Course at the Nagpur University, improvements effected in the College hostel and the shortage of accommodation at the College. The General Secretary then accorded a warm welcome to the guests and read an account of the activities of the College during the year, which included the perforance of students at the examinations, sports and the other extra-curricular activities. He declared that a donation of Rs. 555/- was being sent by the Social Gathering Committee to the Bengal Relief Fund, which received great cheers. He also referred to the deplorable scales of pay of the Subordinate Service in the Agricultural Department which compared most unfavourably with that of other departments, and the regrettable fact that a number of occupants of these posts were not confirmed or given increments for a period extending to even ten years. He pointed out that if better calibre and more enthusiatic work were expected of them the remuneration of this service will have to be raised so as to enable them to live in a reasonable standard of life and possess better status in order to work without an inferiority complex with officers of the same grade of other departments and the landed gentry which looks forward to them for advice.

Sir Geoffrey Burton then gave away the prizes and addressed the gathering. His illuminating address is reproduced in extenso. He envisaged the more important place that agricultural development will occupy in the post-war period and stressed the importance of the part which the agricultural graduates will play in it. He also assured that the matter of the revision of the scales of the Subordinate Agriculture Service will receive proper attention. This gave a great satisfaction to all the present and future occupants of this service who formed the assembly.

The same night Mr. Jogindra Bhushan Acharya gave a performance of yogic feats which were much appreciated. In the end, I express my sincere thanks to our Principal, Mr. Churchill, members of the Social Gathering Committee and my colleagues who spared no pains in making the function a great success.

M. L. Purohit, III year,
General Secretary.

* * *

Examination Results.

ANNUAL PROMOTION EXAMINATIONS 1944.

First year.

1 S. S. S. Venkatrao
2 B. P. Tiwari
3 S. W. Vaidya
4 R. N. Dubey
5 V. G. Pathak
6 D. N. Gadkari
7 R. P. Agrawal
8 R. M. Khandalkar
9 P. S. Shrivastava
10 V. S. Atre
11 S. N. Laddha
12 M. S. Khirwadkar
13 S. M, Deshpande
14 R. P. Shukla
15 L. B. Lanjewar
16 V. H. Kulkarni
17 M. G. Deshaputre
18 K. S. Yawalkar
19 R. C. Modani
20 Yogendra Misra
21 N. B. Trivedi
22 B. P. Shukla
23 M. Y. Chourikar
24 A. K. Verma
25 R. A. Kelapure
26 B. S. Gadre
27 S. K. Bujruk
28 M. A. Moharil
29 Abdul Wahab
30 Y. N. Kunte
31 V. H. Vaidya
32 P. R. Vaidya
33 P. K. Sahasrabudhe

Third year.

1 B. N. Kanungo
2 G. P. Mishra
3 N. G. Hande
4 N. P. Sinnerkar
5 P. S. Malviya
6 S. M. Dahat
7 V. S. Muley
8 M. M. Jamkhindikar
9 R. M. Shende
10 M. L. Purohit
11 K. S. Mahajan
12 K. K. Yerawar
13 C. S. Iyer
14 B. M. Rahangdale
15 H. L. Patel
16 N. K. Maharanwar
17 N. Y. Deshmukh
18 N. N. Dahatonde
19 V. B. Rasal
20 L. A. Patil
21 K. S. Deshmukh
22 G. L. Dahare
23 P. N. Joshi
24 Tayabali

INTERMEDIATE Examination in Science (Agriculture), 19

Serial No. (1)	Name (2)		Division (3)
1	K. L. Nakhtore	...	First
2	P. R. Chopde	....	First
3	A. R. Mankar	....	Second
4	B. K. Gowardhan	....	Second
5	C. S. Vaidya	....	Second
6	C. N. Kathale	...	Second
7	D. D. Shembekar	...	Second
8	G. T. Oke	....	Second
9	G. A. Gangrade	....	Second
10	G. S. Chandel	....	Second
11	K. S. Joshi	....	Second
12	L. N. Dube	....	Second
13	P. N. Mukasdar	....	Second
14	P. K. Kaushal	....	Second
15	R. V. Deshmukh	....	Second
16	R. S. Padmawar	...	Second
17	S. G. Thakare	....	Second
18	S. D. Patwardhan	....	Second
19	S. S. Melag	....	Second
20	S. T. Palekar	....	Second
21	T. W. Kalamkar	....,	Second
22	T. L. Deshpande	....	Second
23	D. R. Degamwar ¶	....	Second
24	R. P. Soni ¶	....	Second
25	N. R. Nigote	....	Third
26	P. D. Shahare	....	Third
27	B. V. Bangde	....	Pass
28	R. H. Dubey	....	Pass
29	S. R. Gokhale ¶	....	Paas
30	K. S. Deshmukh $	....	Pass

31	L. A, Patil $	....	Pass
32	P. N. Joshi $	....	Pass
33	P. S. Malviya $	....	Pass
34	R. S. Maholay $	....	Pass
35	S. M. Dahat $	....	Pass
36	Tayabali $	....	Pass
37	V. P. Chiddarwar $	...	Pass
38	V. B. Rasal $	....	Pass

¶ Under Ordinance No. 20. (Non-Collegiate.)

$ Under paragraph 12 of Ordinance No. 17.

Under the provisions of Paragraph 12 of ordinance No. 17, the following examinees are declared eligible to present themselves at one or more subsequent examinations, only in the subject noted against their respective names.

S. No.	Name.	Subject.
1	P. R. Mundle	Agriculture
2	R. Mandloi	Mathematics and Agriculture Engineering.

Sir Arthur Blennerhassett Memorial Medal is awarded to Khemraj Laljee Nakhtore of the College of Agriculture, Nagpur, for standing first at the Intermediate Examination in Science (Agriculture) of 1944.

B.Sc. (AGRICULTURE) EXAMINATION, 1944.

Serial No. (1)	Name (2)	Division. (3)
1	M. N. Paithankar	First
2	L. Agrawal	First
3	A. C. Jain	First
4	K. G. Nema	First
5	B. G. Bhalerao	Second
6	G. N. Raut	Second
7	J. R. Kakde	Second
8	M. P. Shrivastava	Second
9	M. S. Sonwalkar	Second
10	P. S. Pimpalgaonkar	Second
11	R. R. Rawat	Second
12	S. G. Kulkarni	Second
13	S. N. Khutate	Second
14	B. P. Mishra	Third
15	B. C. Jain	Third
16	C. V. Gaikwad	Third
17	K. N. Awasthi	Third
18	L. G. Kolte	Third
19	S. S. Phadnaik $	Third
20	D. P. Keote $	Third
21	S. B. Thawle ¶	Pass
22	B. G. Wakhale $	Pass
23	R. N. Khandelwal	Pass
24	A. Q. Khan	Pass

$ Under Ordinance No. 20 (Non-Collegiate).
¶ Under Paragraph 11 of Ordinance No. 18.

Under the provisions of paragraph 11 of Ordinance No. 18, the following examinee is declared eligible to present himself at one or more subsequent examinations, only in the subject noted against his name :—

Serial No.	Name	Subject.
1	V. P. Joshi	Chemistry.

1. Sir Arthur Blennerhassett Memorial Medal is awarded to Madhukar Narayanrao Paithankar of the College of Agriculture, Nagpur, for standing first at the B.Sc. (Agr.) Examination of 1944.

2. Chakradeo Memorial Medal is awarded to Madhukar Narayanrao Paithankar of the College of Agriculture, Nagpur, for obtaining the highest number of marks at the B.Sc. (Agr.) Examination of 1944, from among the examinees admitted to the examination for the first time and placed in the first division.

PRIZE WINNERS 1942–43.

Name of the Prize	*Subject in which awarded*	*To whom awarded*
Fourth Year		
1 Smythies Chemical Medal	Chemistry	Deo Dutta Shukla
2 The Napier Essay Prize	Essay	B. M. S. Bhuwal D. D. Shukla G. T. Saoji
3 Special Prize	Agriculture	P. S. Parsai
4 Special Prize	Entomology	P. S. Parsai
5 Special Prize	Botany	D. N. Khardekar
6 Special Prize	Veterinary	D. N. Khardekar
Thjrd Year.		
7 Kedarnath Rai Medal	Implements, and Machinery	M. N. Paithankar
8 Kalidas Choudhari Medal	Practical Agriculture	A. C. Jain
9 Class prize	Best all round Student	A. C Jain

Second Year.

10	Coronation Commemoration Prize	Best all round student	N P. Sinnerkar
11	Class Prize	Mathematics & Survey	N. P. Sinnerkar
12	Class Prize	Elementary Science	B. N. Kanungo
13	Class Prize	Agriculture	B. N. Kanungo

First year.

14	Special Prize	Best all round student	P. R. Chopde
15	Class Prize	General Agriculture	K. L. Nakhtore
16	Class Prize	Practical Agriculture	K. L. Nakhtore
17	Class Prize	Mathematics & Survey	P. D. Shahare

Private Prize.

18	Phatak's Prize	Agriculture (IIIyear)	A. C. Jain

Elocution Competition

English :—Mr. N. G. Hande...
Marathi :—Mr. S. D. Patwardhan....
Hindi :—Mr. B. P. Tiwari....

Sports (Athletics).

Mr, C. S, Iyer	100 yards Race	.... First
	220 yards „	.... First
	440 „ „	... First
	3 miles Race	... First
	High Jump	.... First
	Long Jump	.... First
	Hop Step & Jump	.... First
Mr. N. K. Maharanwar	100 Yards Race	.... Second
	880 Yards „	.... Second
	1 Mile „	.... First

	Long Jump	... Second
	Hop step and Jump	... Second
Mr. R. A. Kelapure	220 yards Race	... Second
	High Jump	... Second
Mr. C. S. Vaidya	440 yards Race	... Second
Mr. R. S. Padmawar	880 yards Race	.... First
	1 Mile ”	... Second
Mr. S. G. Thakray	3 Miles Race	.... Second
Mr. P. K. Kaushal	3 Miles Race	.... Third
Mr. M. G. Saoji	Bullock Race	.... First
Mr. V. B. Rasal	Swimming 100 yards	..... First
	” 220 yards	... First
Mr. S. N. Khutate	Swimming 100 yards	.... Second
	” 220 Yards	.... Second
Mr. C. S. S. Mudliar	Shot put	.... First
Mr. B. S. Gadre	”	... Second

Relay *Race*
(Interclass) III Year
Mr. K. S. Deshmukh and
Mr. C. S. Iyer

Relay *Race*
Staff, past and
Present Students

Winners:
past students
Mr. G. T. Saoji
Mr. D. G. Dakshindas
Mr. G. S. Pawar
Mr. R. S. Melag

Outdoor and Indoor Games

		Captain
Interclass Football	II Year	M. G. Saoji
” Hockey	II Year	C. S. Vaidya
” Basket Ball	III Year	V. S. Muley
” Volley Ball	III Year	K. S. Deshmukh
” Hu-tu-tu	IV Year	V. P. Chiddarwar

Volley Ball Doubles

Winners :-Mr. R. N. Khandelwal and Mr. S. N. Khutate
Runuers-up:-Mr. M. L. Purohit & Mr. C. S. Iyer

Carrom (Doubles)

Winners :- Mr. R. N. Khandelwal and
Mr.S. N. Khutate
Runners-up:- Mr. M. N. Paithankar and
Mr. C. S. Vaidya

Chess

Winner :- Mr. L. Agrawal
Runner-up:- Mr. V. G. Lokras

All round Sportsmanship

Prize:- Mr. C. S. Iyer

Colour holders for the year 1943-44:-

Football :- (1) Mr. C. S. Iyer
(2) Mr. S. G. Kulkarni
Hockey :- (1) Mr. C. S. S. Mudliar

Supplement to Nagpur Agr. College Mag. Vol. XVIII *Nos. 3 & 4, Feb. & June '44.*

Application of Quasi—Factorial technique in trials of Rabi Til Strains.

By

DHANNALAL.

Til is the second important oilseed crop of the Central Provinces, occupying an area of nearly 199,378 acres. It is mainly grown for the extraction of oil from its seeds, and is used in most parts of India for culinary purposes. As a rule two crops of til, kharif and rabi, are generally grown in C. P. The former is sown about the last week of June after the first heavy showers of the monsoon and is harvested in the last week of October or the 1st week of November, whereas the latter or the rabi til is sown in the last week of August or in the first week of September and ripens in about 4½ months time, being harvested in December or January. Kashi Ram(1) writing about the til crop in general and Ali Mohammad and Jafar Alam(2) who have described those of the Punjab, do not mention the occurrence of a second crop viz, the winter one though Rind and Thein(3) in their article on the tils of Burma have certainly described the rabi one as well.

A considerable amount of work has already been done on this crop in the various provinces of India and breeding of high yielding strains with a view to increase the oil percentage was started in practically all the til growing provinces, during the last 2 decades. Howard, Howard and Khan(4), McGibbon(5), Odell F. D.(6), Kashiram, Roy S. C.(7), Mclean, A(8), Rind D. and Thein V. B. Ali Mohammad and Zafar Alam, Richharia R. H.(9), have studied the various aspects of the crop from time to time and recorded their observations at different periods. In C. P. the average yield per acre has been found to be very low and the varieties grown by the cultivators are often mixed and are of inferior quality. In order to isolate the different types possessing important economic characters such as higher yield, larger percentage of oil, resistance to frost and drought sepaloid free cultures etc. a collection of seeds of about 1,000 samples from the various districts of this province as well as from other research centres in India and foreign countries was made in 1937. These seed samples diferred considerably from one another in colour, size, weight, seed coat etc. There were mainly six colours that were found to be prominent viz., white, brown, dark brown, light brown, black and light back with short medium and large sized seeds. Weights of these varied from class of colour to another while the seed coats of some were either rough or smooth. They were thus classified into different types mainly with regard to their difference in colour and size and were sown in single lines. 3,500 single line cultures of these were grown and studied. As a priliminary step, the material was classified into kharif and rabi types. The latter, when grown during kharif season threw in a lot of vegetative growth with delayed flowering. Thus this class of plants (rabi) were easily distinguished from the rest of the material, and separated out. Mclean (1932) also records the same characteristic in rabi varieties, behaving in the same way when sown during monsoon season. In 1938, 165 lines of rabi tils thus selected were grown in single line cultures and studied, out of which, 158 individual strains were selected with respect to good bearing and early maturity and were selfed. Seeds from each plant were collected separately and analysed for colour variation. Eight kinds of colours as against 35 in kharif types viz, yellowish salmon, reddish salmon, cinnamon, burnt umber, raw umber, brownish drab, hazel and snuff brown were selected. Colour variation in kharif tils, however, was much more frequent than in rabi ones.

Progenies of these 158 plants were again grown in single lines and studied in 1939. Out of these only 38 have been retained as they possessed various economic characters.

Selections were also made from Puri Maghi til, an important rabi strain grown on a large scale, chiefly in the Hoshangabad District of the Central Provinces. The work was commenced in the year 1937, when 11 selections were made from a field of that crop at Powarkheda Farm (Hoshangabad). During the year 1938, out of these 11, one segregated and 10 bred true for seed colour. In 1939, Progenies of these 10 individual plants were grown in small plots and selfed by covering with muslin nets, in the fashion of a mosquito curtain. 29 Progeny cultures were finally selected, the details of which are given below in Table I.

Table I.

Selection from Purbi Maghi Til.

Serial No.	Single plant selections made in 1937.	Number of plants obtained during 1938.	No. of pure culture plots raised in 1939	Number of plots finally selected representing individual plant cultures possessing desirable characters.
1	P/1	9	9	3
2	P/2	11	11	3
3	P/3	16	16	1
4	P/4	4	4	1

5	P/5	6	6	4
6	P/6	19	19	3
7	P/8	5	5	1
8	P/9	8	8	2
9	P/10	6	6	5
10	P/11	10	10	6
			Total	29 Plots

Out of the other 38 selections made from the local miture as mentioned previously, selfed seeds from 36 were obtained in 1939. A study of their seed colour, however, showed 28 cultures to be breeding true as may be seen in Table II, while eight segregated into different colours as shown in Table III.

Table II.

Cultures of rabi til breeding true.

Serial No.	Referance No.	No. of plauts obtainedin 1940, in F 2 generation,	Seed colour in F 2 breading true	No. of families raised in F 3 passessing desirable characters
1	2R	16	Burnt Umber	7
2	37R	6	Brunt Umber	1
3	31R	4	Faint mineral brown	3
4	24R	5	Brown	4
5	33R	20	Dirty brown	20
6	33R	8	Deep brown	1
7	13R	4	Deep Burnt Umber	2
8	25R	6	Burnt Umber	I
9	16R	6	Light Burnt Umber	2
10	9R	13	Burnt Umber	6
11	38R	11	Fawn	1
12	32R	24	Medium Burnt Umber	1
13	10R	6	Light Burnt Umber	3
14	23R	8	Medium Burnt Umber	1
15	27R	7	Medium Burnt Umber	2
16	21R	4	Deep Fawn	1
17	18R	7	Burnt Umber	3
18	22R	14	Medium Brunt Umber	1
19	30R	13	Medium Fawn	3
20	19R	14	Medium Burnt Umber	3
21	3R	16	Medium Burnt Umber	3
22	14R	6	Fawn	1

23	4R	7	Medium Burnt Umber	1
24	7R	8	Medium Burnt Umber	2
25	15R	8	Medium Burnt Umber	8
26	11R	13	Medium Burnt Umber	4
27	26R	5	Light Fawn	1
28	36R	3	Medium Burnt Umber	2

Table III.

Segregating families of rabi til.

Serial No,	Referance No.	Number of plants studied	Segregating seed colours in F2.	
1	34R	22	Brown 19	Faint brown 3
2	29R	20	Brown 12	Faint brown 8
3	12R	12	Burnt umber 10	Sepia 2
4	36R	4	Burnt umber 3	Sepia 1
5	1R	13	Burnt umber 9	Light burnt umber 4
6	6R	18	Burnt umber 8	Sepia 10
7	5R	3	Burnt umber 2	Light burnt umber 1
8	8R	4	Burnt umber 2	Sepia 2

During 1940 certain cultures were picked out and again grown in order to study their behaviour in the next genration. 45 selections and 4 from p. m. Til., thus making 49 cultures were made from these and their behaviour in respect of their economic characters were studied as given in table iv.

Out of the Purvi Maghi Til selections, 29 cultures representing the progeny bulks of 10 individual plant selections made in 1937 (Table I) were tried in randomised blocks with local samples of Purvi Maghi Til as control. From the results of these, two strains P 6 and P 10 appeared promising and were selected.

TABLE IV.

Statement showing the behaviour of the different selected strains in the next generation.

Serial No.	Reference No.	Economic Characters				Alloted number
		No. of flowers in each axil		Locular condition (to be further experimented)	Seed Colour in the next generation.	
		Solitary	Multiple			
1	19R(2)	—	Multiple	Four	Medium burnt umber	11
2	15R(5)	Solitary	Multiple	Four	Burnt umber Medium burnt nmber Purplish Tinted White.	21
3	33R(18)	—	Multiple	Four	Purplish tinted white	31
4	25R(1)	—	Multiple	Four	Purplish tinted white Different shades of burnt umber.	41
5	5R	Solitary	—	Four	Deep burnt umber Purplish tinted white	51
6	SepiaII 8R(3)	—	Multiple	Four	Sepia Sepia i Sepia ii	61
7	16R(1)	Solitary	Multiple	Four	Light burnt umber	71
8	34R(7)	Solitary	Multlple	Four	Burnt umber Purplish tinted white	12
9	19R(3)	Solitary	Multiple	Four	Medium burnt umber	22
10	9R(5)	Solitary	Multiple	Four	Deep burnt umber	32
11	2R(6)	—	Multiple	Four	Burnt umber	42
12	Sepia I 8R(3)	—		Four		52
13	P.M. 6/10	Solitary	—	Four	Yellow	62
14	36R(1)	Solitary	Multiple	Four	Deep burnt umber Light burnt umber	72
15	19R(1)			Four		13
16	18R(2)	Solitary	—	Four	Light burnt umber	23
17	36R(2)	—	Multiple	Four	Medium burnt umber	33
18	33R(14)	—	Multiple	Four	Purplish tinted white	43
19	15R(6)	Solitary	Multiple	Four	Burnt umber Purplish tinted white	53
20	15R(1)	Solitary	Multiple	Four	Medium burnt umber	63
21	7R(1)			Four		73
22	12R(3)			Four		14
23	6R(1)	—	Multiple	Four	Burnt umber	24
24	18R(1)			Four		34

25	33R (5)		Multiple	Four	Purplish rinted white	44
26	13R (1)			Four		54
27	6R (6)		Multiple	Four	Burnt umber	64
28	33R (12)		Multiple	Four	Segregating Purplish tinted	74
29	34R (6)	Solitary		Four		15
30	Dusty 38R (3)		Multiple	Four		25
31	Sepia 15R (8)			Four		35
32	33R (6)		Multiple	Four	Purplish Tinted white	45
33	P. M. 6/17	Solitary		Four	Yellow	55
34	33R (9)		Multiple	Four	Purplish Tinted white	65
35	14R		Multiple	Four	Burnt umber Purplish Tinted white	75
36	30R			Four		16
37	33R (4)		Multiple	Four	Purplish Tinted white	26
38	15R (7)	Solitary	Multiple	Four	Light medium umber Burnt umber	36
39	33R (13)		Multiple	Four	Purplish Tinted white	46
40	P. M. 6/2	Solitary		Four	Yellow	56
41	33R (20)		Multiple	Four	Purplish Tinted white	66
42	P. M. 6/8	Solitary		Four	Yellow	76
43	25R (2)			Four		17
44	13R (2)	Solitary		Four	Sepia	27
45	15R (3)	Solitary	Multiple	Four	Burnt umber Purplish Tinted white	37
46	1R (1)		Multiple	Four	Light burnt umber Burnt umber	47
47	11R (20)		Multiple	Four	Light Burnt umber	57
48	10R (1)	Solitary	Multiple	Four	Deep burnt umber	67
49	34R (6)	Solitary	Multiple	Four	Segregating	77

Yield Trial:—The 49 strains, mentioned above were then tried with reference to their yield performance by a design known as Quasi-Latin or Lattice squares. This type of design was first described by "Yates" (1937). In essence it consists of a set of randomised blocks, in which the plots of each block from a square pattern on the ground, certain restrictions being imposed on the randomisation within the blocks. These restrictions enable the difference between the rows and the columns of each block to be eliminated either partially or entriely from varietal comparisons.

For the sake of convenience the 49 varieties referred to above were renamed as given in the last column of, Table IV, and were arranged in the from of, square as shown below :—

11	21	31	41	51	61	71
12	22	32	42	52	62	72
13	23	33	43	53	63	73
14	24	34	44	54	64	74
15	25	35	45	55	65	75
16	26	36	46	56	66	76
17	27	37	47	57	67	77

Here the varieties are arranged in two groups of seven sets each, each set consisting seven varieties. The seven sets of the first group, the row group-are formed out of the seven rows and the seven sets of the second group-the column group, are formed out of the seven columns of the above square. Each set thus contains seven varieties, and each group makes a complete replication. Each group is repeated three times, thus making a total of six replications for the whole experiment. The seven sets within each group and the seven varieties within each set are completely and independently randomized in each replication. Each set thus formed an independent block, with the result that, with a plot of the size of 5′ x 5′ the block size was reduced to 35′ x 5′ or 175 squre feet. If a completely randomized block experiment were to be arranged the block size would have been 35′ × 35′ or 1225 sq. ft. The design of layout and the yields of varieties are given in Table V. This table gives the block totals and the replication totals only.

Table V on the next Page.

Table V

Set of lattice Squares for 49 varieties and their yield in ounces per plot (size 5' x 5')

Replication I.

														Block Total
35	4.250	55	2.500	15	4.625	65	2 000	25	3.250	45	2 250	75	4.125	23.000
22	3.375	72	2.750	52	4.500	42	2.875	32	3.250	62	1.500	12	4.000	22.250
11	2.750	31	2.375	51	2.375	71	3 125	21	2.750	61	4.000	41	3.625	21.000
26	1.875	66	2.750	16	3.750	46	2.750	56	0.750	36	2.750	76	2.500	17.125
73	2 000	33	3.000	13	4.625	63	4.625	53	3.750	43	1 250	23	3.875	23.125
34	4.125	54	2.125	14	2.750	64	3.875	74	2.750	24	2.750	44	3.375	21.750
47	2.875	27	1.500	77	1.625	57	2.750	67	3.000	17	2.500	37	2.375	16.625
														144.875

Replication II.

27	1.875	77	0.625	57	3.500	37	5,250	47	3.500	67	4.250	17	5.875	24.875
53	2.125	13	4.250	63	5.250	73	4.000	43	2.500	33	2.875	23	3.875	24.875
36	2.250	56	4.375	76	2.750	66	5.750	16	2.750	26	5.375	46	1.875	25.125
62	3.625	12	2.750	22	4.625	42	4.750	52	4.750	32	1.500	72	2.000	24.000
55	4.875	14	3.125	34	1.625	64	2.875	34	4.250	24	4.000	44	4.250	25.000
41	3.000	61	5.250	71	2.375	11	4.250	31	3.375	51	4.750	21	3.375	26.375
75	5.750	45	2.000	15	2.500	35	3.000	65	4,250	25	5.225	55	4.000	26.875
														177.125

Replication III.

62	3.500	12	3,500	42	1.750	72	2.250	32	1.750	52	6.250	22	2,250	21.250
34	2.750	14	2.500	54	2.125	24	3.750	64	4.450	44	3.375	74	0.500	19.500
56	1.250	76	3.625	16	3.500	66	1,750	26	0.500	46	1.625	76	1.750	14.000
37	1.750	57	2.750	17	2.750	47	2.125	27	1.000	67	3.875	77	2.500	16.750
41	4.125	21	1.250	11	2.625	61	2.250	31	1.250	71	5.875	51	3.125	20.500
73	4.250	33	1.750	63	2.375	23	2.625	43	1.750	13	2.000	53	1.625	17.375
45	1.250	75	3.000	65	2.375	25	4.500	55	1.875	35	2.750	15	3.750	19.500
														128.875

Replication IV.

11	3.500	21	1.625	31	1.625	41	2.625	51	1.625	61	2.500	71	3.125
12	2.500	22	4.000	32	2.500	42	2.000	52	1.625	62	0.750	72	2.250
13	0.750	23	2.750	33	1.500	43	3.125	53	0.750	63	1.750	73	2.000
14	1.000	24	1.875	34	0.375	44	1.000	54	3.375	64	3.000	74	2.625
15	2.500	25	1.875	35	1.000	45	1.750	55	1.500	65	4.250	75	1.125
16	1,750	26	1.375	36	0.500	46	0.875	56	1.375	66	1.250	76	0.750
17	1.500	27	2.500	37	2.875	47	0.500	57	2.250	76	2.750	77	2.125
B.T.	13.500		16.000		10.375		11.875		12.500		16.250		14.000
													94.500

Replication V.

16	3.500	26	0.750	46	3.250	66	2.250	36	1.750	76	5.625	56	2.125
13	3.125	23	2.750	43	4.000	63	1.500	33	1.250	73	2.500	53	2.250
14	2.000	24	3.625	44	3.750	64	3.875	34	3.125	74	3.000	54	4.875
11	3.375	21	1.000	41	5.875	61	5.250	31	1.000	71	2.500	51	6.500
12	3.750	22	2.625	42	4.375	62	3.250	32	2.500	72	2.250	52	4.000
15	3.750	25	1.500	45	4.625	65	2.375	35	2.500	75	4.750	55	5,000
17	2.000	27	5.250	47	2.250	67	2.625	37	3.750	77	4.500	57	4 625
B. T.	21.500		17.500		28.125		21.125		15.875		25.125		29.375
													158.625

Replication VI.

51	2.625	71	3.000	11	2.750	31	1.500	41	2.000	61	3.500	21	1.500
12	2.250	72	2.625	12	4.500	32	1.750	42	2.625	62	2.000	22	2.625
55	2.250	75	2.375	16	1.500	33	1.000	43	2.625	63	1.375	23	3.250
56	1.875	76	1.625	15	1.250	34	1.500	44	3.000	64	4.125	24	6.250
54	1.750	74	2.500	17	2.500	35	1,500	45	0.750	65	2.250	25	2,875
53	1.500	73	2.875	13	1.625	36	0.500	46	1.200	66	2.700	26	1.875
57	1.375	77	2.250	17	1.375	37	1.375	47	1.125	67	2.500	27	1,250
B. T.	13.625		17.250		15.500		9.125		13.375		18.500		19,625
													107.000

The various steps involved in the analysis are explained in Appendix A at the end. The Xvu, Yvu and the Tvu tables corresponding to the row sets, column sets and row and column sets combined are set up in Table VI.

Table VI.

Total yields of varieties in ounces by sets.

I Row Sets.

														Column Total
11	9.625	12	10.250	13	10.875	14	8.375	15	10.875	16	10.000	17	11.125	71.125
21	7.375	22	10.250	23	10.375	24	10.500	25	12.875	26	7.750	27	4.375	63.500
31	7.000	32	6.500	33	7.625	34	8.500	35	10.000	36	6.750	37	9.375	55.750
41	10.750	42	9.375	43	5.500	44	11.000	45	5.500	46	6.250	47	8.500	56.875
51	10.250	52	15.500	53	7.500	54	9.125	55	8.375	56	6.375	56	8.000	65.125
61	11.500	62	8.625	63	12.250	64	11.250	65	8.875	66	10.250	67	11.125	73.875
71	11.375	75	7.000	73	10.250	74	7.500	75	12.875	76	8.875	77	4.750	62.625
Row Total	67.875		67.500		64.375		66.250		69.375		56.250		57.250	448.875

II Column Sets.

														Row Total
11	9.625	12	10.750	13	5.500	14	5.500	15	7.750	16	6.500	17	4.875	50.500
21	4.125	22	9.250	23	8.750	24	11.750	25	6.250	26	4.000	27	9.000	53.125
31	4.125	32	6.750	33	3.750	34	5.000	35	5.000	36	2.750	37	8.000	35.375
41	10.500	42	9.000	43	9.750	44	7.750	45	7.125	46	5.375	47	3.875	53.375
51	10.750	52	7.875	53	4.500	54	10.000	55	8.750	56	7.375	57	8.250	57.500
61	11.250	62	6.000	63	4.625	64	11.000	65	8.875	66	6.250	67	7.875	55.875
71	8.625	72	7.125	73	7.375	74	8.125	75	8.250	76	8.000	77	8.875	56.375
Column Total	59.000		56.750		44.250		59.125		52.000		40.250		50.750 =	362.125

III Row and Column Sets Combined

11	19.250	12	21.000	13	16.375	14	13.875	15	18.625	16	16.500	17	16.000	121.625
21	11.500	22	19.500	23	19.125	24	22.250	26	19.125	26	11.750	27	13.375	116.625
31	11.125	32	13.250	32	11.375	34	13.500	35	15.000	36	9.500	37	17.375	91.125
41	21.250	42	18.375	43	15.250	54	18.750	45	12.625	46	11.625	47	12.375	110.250
51	21.000	52	23.375	53	12.000	54	19.125	55	17.125	56	12.750	57	17.250	122.625
61	22.750	62	14.625	63	16.875	64	22.250	65	17.750	66	16.500	67	19.000	129.750
71	20.000	72	14.125	73	17.625	74	15.625	75	21.125	76	16.875	77	13.625	119.000
T.	126.875		124.250		108.625		125.375		121.375		95.500		109.000 =	811.000

The analysis of the variance is given in Table VII below

TABLE VII.

Analysis of variance.

Due to	D. F.	Sum of squares.	Mean squares.	F. Found	F. Required 5%	F. Required 1%
Replications	 5	99.832	19.666			
Component (a)	24	37.816				
Component (b)	12	11.420				
Blocks (eliminating varieties)	 36	49.236	1.368			
Varieties (ignoring blocks) ...	 48	95.094	1.981	1.77	1.42	1.62
Error	 204	229.880	1.127			
Total	 293	474.042				

Variance for mean of 6 = 0.1817.

Variance of the difference of two means (varieties) in the lsame block = 4.2567 and S. E. = 0.704.

Variance of the difference of two means not in the same bock = 4.7889 and S. E. = 0.746.

From the "t"—tables it is found that for 204 degrees of freedom the expected value of "t" is 1.972 at 5% level of significance, 2.601 at 1% level of significance.

Hence the critical difference of varieties within the same set is = 0.704 × 1.972 = 1.389 at 5% level of significance and 0.704 × 2.801 = 1.831 at 1% level significance.

Similarly the critical difference of varieties not in the same set is 0.746 × 1.972 = 1.471 at 5% level of significance and 0.746 × 2.601 = 1.940 at 1% level of significance.

It is clear from the "F" value for varieties, at they differ significantly in yield, both at 5% and at 1% level of significance.

The mean yields of varieties in terms of ounces per plot together with the row and column correction necessary to adjust the yield is given in Table VIII below.

TABLE VIII.

11	3.208	12	3.500	13	2.729	14	2.313	15	3 104	16	2.733	17	2.666	—0.491
21	1.917	22	3.250	23	3.188	24	3.708	25	3.188	26	1.958	27	2.229	—0.247
31	1.854	32	2.208	33	1.896	34	2 252	35	2.500	36	1 583	37	2.896	—0.486
41	3.542	42	3.063	43	2.542	44	3.125	45	2.104	46	1.938	47	2.063	—0.084
51	3.500	52	3.896	53	2.000	54	3 188	55	2 854	56	21.25	57	2.875	—0.182
61	3.792	62	2.438	63	2.813	64	3 708	65	2.958	66	2.750	67	3.167	—0.429
71	3.333	72	2.354	73	2.938	74	2.604	75	3 521	76	2.813	77	2.271	—0.149
+0.211		+0.256		+0.479		+0.170		+0.413		+0.384.		+0.155		

The yields have been adjusted and converted into maunds per acre mound 40 seers or 82.2 lbs.). These are tabulated in Table IX below.

TABLE IX.

11	3.880	12	4.326	13	3.600	14	2.639	15	4.009	16	3.479	17	3.087
21	2.492	22	4.318	23	4.531	24	4.811	25	4.444	26	2.776	27	2.931
31	2.092	32	3.620	33	2.503	34	2.562	35	3.216	36	1.962	37	3.399
41	4.861	42	4.286	43	3.891	44	4.254	45	3.224	46	2.965	47	2.827
51	4.676	52	5.260	53	3.043	54	4.208	55	4.008	56	3.083	57	3.774
61	4.735	62	3.000	63	3.793	64	4.570	65	3.898	66	3.584	67	3.833
71	4.498	72	3.261	73	4.330	74	3,478	75	5.015	76	4.039	77	3 017

From the value of the critical difference given below Table VII it may easily be seen that the critical difference for varietal comparison for Table IX will be as follows :—

	Critical Difference at 5%l evel.	1% level.
Verieties in the same set	.... 1.840	2.426
Varieties not in the same set	.... 1.949	2.570

As the object is to select the best varieties it is better to stick to the critical difference at the 5% level of significance. In that case the varieties may be divided in the following groups.

Group (i)		Group (ii)		Group (iii)	
Varieties	Yields in Mds. per acre	Varieties	Yields in Mds. per acre	Varieties	Yields in Mds per acre
52	5.260	16	3.479	36	1.962
75	5 015	74	3.478		
41	4.841	37	3.399		
24	4.811	72	3.261		
61	4.735	45	3.224		
51	4.676	35	3.216		
64	4,570	17	3.087		
23	4.531	56	3 083		
71	4 498	53	3.043		
25	4.444	77	3.017		
73	4,330	62	3.001		
12	4.326	46	2.965		
22	4.318	27	2.831		
42	4.286	47	2.827		
44	4.254	26	2.776		
54	4.208	14	2.639		
55	4.088	32	2 620		
76	4.039	34	2.562		
15	4.009	33	2.503		
65	3 898	21	2.492		
43	3.891	31	2.092		
11	3.880				
67	3.833				
63	3.793				
57	3.774				
13	3.600				
66	3.584				

The varities in each group are not significantly different from each other, although the first and the second, and the second and the third groups have some varieties which are also not singnificantly different.

It is intended to carry on the work further by restricting the selection to the first group only and by means of a more rigid-test to reduce the numbers to a few of the very best yielding types.

SUMMARY.

1. As a result of breeding and selection work done during the last 5 years, 49 strains of Rabi Til possessing important economic characters have been isolated from the materials collected from different parts of the country.

2. Their various economic characters e. g. number of flowers in each axil, locular condition, seed colour etc. have been discussed.

3. In order to reduce their number and to select the best yiedlers, a quasi-factorial technique of yield-trial experiment was conducted during 1941. The yields are statistically analysed and the varieties are grouped into 3 groups according to their merits.

* * *

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APPENDIX I.

No attempt has been made here to go into the theoretical details of the design. What is given is just the minimum bare outline of the various steps involved in the analysis.

Supposing that we have p^2 varieties arranged in a p x p square. As usual we lay the design by breaking them into p sets of p varieties each, both row wise and column wise with the help of the above square; these give us the two groups, the row group and the column group, each of which makes a complete replication. Let there be 2n replication, n for the row group and n for the column group. Let Xvu be the total of the n yields of the variety vu occuring in the u th column of the main sqnare; Yvu the total of the n yields of the same vu th variety occuring in the v th column of the main square and Tvu th total yield of the vu th variety for all the 2 replications. Let these yields be arranged in the tabular form as follows :—

(Row sets)

							X.u
	X11	X21	X31	X41	X51	X61	X.1
	X12	X22	X32	X42	X52	X62	X.2
	X13	X23	X33	X43	X53	X63	X.3
	X14	X24	X34	X44	X54	X64	X.4
	X15	X25	X35	X45	X55	X65	X.5
	X16	X26	X36	X46	X56	X66	X.6
Xu.	X1.	X2.	X3.	X4.	X5.	X6.	X.

Y.6

(Column Set)

							Y.u
	Y11	Y21	Y31	Y41	Y51	Y61	Y.1
	Y12	Y22	Y32	Y42	Y52	Y62	Y.2
	Y13	Y23	Y33	Y43	Y53	Y63	Y.3
	Y14	Y24	Y34	Y44	Y54	Y64	Y.4
	Y15	Y25	Y35	Y45	Y55	Y65	Y.5
	Y16	Y26	Y36	Y46	Y56	Y66	
Yv.	Y1.	Y2.	Y3.	Y4.	Y5.	Y6.	Y.

(All Replications)

							T.u
	T11	T21	T31	T41	T51	T61	T.1
	T12	T22	T32	T42	T52	T62	T.2
	T13	T23	T33	T43	T53	T63	T.3
	T14	T24	T34	T44	T54	T64	T.4
	T15	T25	T35	T45	T55	T65	T.5
	T16	T26	T36	T46	T56	T66	T.6
Tv.	T1.	T2.	T3.	T4.	T5.	T6.	T.

There will be 2 np blocks in all, each block containing p varieties. If the block total is denoted by B (k=1, 2, np) the sum of the squares due to blocks is given by (k= 1, 2,....,2np)$_k$

$$\frac{1}{p}\sum_{k=1}^{2np} B^2_K - \frac{T.^2.}{2np};$$

There being 2np–1 degrees of freedom. The sum of squares due to varieties is given, using Yates short cut (1936)

$$\frac{Tu^{v2}}{2n} + \sum\frac{(X.u - Y.u)^2}{2np} + \sum\frac{(X^v. - Y^v.)^2}{2np} - \frac{(X.... - Y....)}{2np^2}$$

$$- \frac{\sum (X.^u)^2 + \sum (Tv.)^2}{np}$$

The degree of freedom being p^2-1. The error sum of squares is then easily found from the total sum of squares ($2np^2-1$ degrees of freedom) by substracting the sum of squares due to blocks and varieties from the total sum of squares. Obviously there will be $(p-1)(2np-p-1)$ degrees freedom for the error sum of squares. The analysis of variance table is then easily set up.

In comparing the yields of any two varieties we must bear in mind that such a comparison is valid only if the two varieties occur in the same block, or, if they occur in different blocks, the different block effects are some how compensated. Before making the comparisons, therefore, the varietal yields have to be adjusted for block effects. The least square method gives the following formula for arriving at the adjusted yield of the vu th variety.

$$tvu = \frac{Tvu}{2n} + \frac{1}{2np}(Xv.-Yv.) + \frac{1}{2np}(Yu. - Xu.) \quad , (u, v=1, 2 \dots P)$$

It facilitates calculations to set up the corrections

$$Cv. = \frac{1}{2np}(Xv. - Yv.) \text{ and } R.u = \frac{1}{2np}(Y.u - X.u)$$

in the margin of the *Tuv* table, What is then required is simply to add Cv, to all varieties in the v th Column and to add R. u to all varieties in the u th row,

A further caution is necessary in comparing the two varietal yields, If s^2 is the error variance per plot, the variance of the difference between the adjusted means of the varieties that occur in the same set is given by

$$\frac{s^2}{n} \; \frac{p+1}{p}$$

Whereas the variance of the difference between the adjusted means of two varieties not occuring in the same set is given by

$$\frac{s^2}{n} \left(\frac{p+2}{p}\right)$$

In the case under consideration we have, $p=7$ and $n=3$,

The late Mr. Shridharrao Gokhale Memorial Volley-Ball Tournament 1943.

The above tournament was run for the first time in December 1943 by the Sports Committee of the College of Agriculture, Nagpur, in memory of the late Mr. Shridharrao Gokhale, Advocate, Nagpur, who was closely associated with this College as its well-wisher. A challenge shield has been kindly donated by R. S. Dabir Esq. Advocate, Nagpur, to be awarded to the winners of the tournament and thanks to the Friends Union, Nagpur, which has given a cup for the runners-up to commemorate the memory of the late Mr. L. J. Kokardekar, Director of Physical Education, Nagpur University. The tournament is open to all the institutions affiliated to the Nagpur University. The tournament was run on the court of the College of Agriculture, on the 15th and 16th December 1943. In all, eight teams participated. An entrance fee of Rs. 5/- was charged. The College of Science won the finals by defeating the College of Agriculture. The tournament showed a high standard of performance by the various teams.

Mr. E. A. H. Churchill presented the shield to the winners, the cup to the runners and a number of other prizes to players of different teams for commendable performance. In a short speech he gave an account of the great interest which the late Mr. Gokhale took in agricultural education, and how he was actively engaged in his life in doing his best for it. He referred to the great contribution which the late Mr. L. J. Kokardekar made to physical culture in a short span of life which ended in sorrowful circumstances.

As the Nagpur University is at present not running a tournament in Volley Ball which has sprung into great popularity in recent years, this tournament caused great interest, as is evident from the number of teams which participated.

R. N. Khandelwal, III year,
Secretary.

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